Searching for Sustainable Solutions in Improved Cook Stove Practice in Malawi

A Cultural Historical Activity Theory Approach

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Abstract

The Improved Cook-Stove (ICS) has the potential to contribute to sustainable firewood harvesting and consumption in Malawi because it is energy efficient. However, accelerated uptake, utilisation and production of ICSs put stress on ICS construction materials. Findings from a qualitative case study that explored uptake and use of ICSs in Ehlonipeni demonstrate that ICS production is putting pressure on ndhulani, a major material in ICS construction. It is contributing to slow stove construction and jeopardising the growth of the ICS practice. This paper argues for 'boundary crossing learning' in the search for more sustainable solutions to address the challenge. It recommends: that key activity systems in ICS practice utilise pluralism and diversity in exploring sustainable solutions; and that facilitation of 'boundary crossing laboratories' is necessary to support this endeavour.

Introduction

The majority of the population in Malawi[1] depend on wood-based fuels, such as charcoal and firewood, for their energy requirements. Nearly 96 per cent of rural households and 42 per cent of urban households depend on firewood for cooking.[2] Cooking energy from wood fuel is at 97 per cent[3] and households account for 83 per cent of all energy consumption.[4]

The country's current patterns of energy use for cooking have become environmentally unsustainable.[5,6] The major challenge is the need to expand access to essential energy services and provide energy efficient cooking technologies for poor rural populations. The Improved Cook Stove (ICS) is the energy technology with the most potential to reduce environmental health risks faced

by people using traditional biomass fuels indoors.[7] It helps to reduce greenhouse gases (GHGs)[8] and deforestation.[9] It is being promoted in response to environmental challenges in Malawi and many other developing countries.[10] However, there are some challenges experienced with the implementation of ICSs in some parts of Malawi. This paper discusses a sustainability challenge in relation to material scarcity faced by ICS practice[11] in Ehlonipeni:[12] one of the major ICS construction materials, ndhulani,[13] is becoming scarce.

Findings presented in this paper emanate from data collected using semi-structured individual and group interviews and observations. I employed qualitative data analysis informed by Cultural Historical Activity Theory's (CHAT) notions of activity system[14] and boundary crossing,[15] and guided by the principle of contradictions.[16] The data used in this paper were collected in Ehlonipeni, in June 2015. The findings reveal: the material challenges faced due to scarcity of the stove construction material; and the solutions envisaged by research participants.

The findings indicate that there is potential to resolve contradictions in ICS practice through boundary crossing learning processes. The manifestation of boundary crossing learning in the data provides potential for successful implementation of boundary crossing laboratories[17] among the key actors involved in ICS practice. Boundary crossing learning may lead to finding more sustainable solutions to the sustainability challenge in Ehlonipeni.

The article begins with an overview of ICSs in Malawi, giving the main objectives for promotion of cook stoves, including the key disseminating institutions. It then provides a description of the firewood situation and the promotion of cook stoves in Ehlonipeni, before explaining the sustainability challenge experienced in relation to material scarcity. The next section provides an overview of CHAT, as a theoretical framework for the study. The study approach and main findings are then presented, followed by a discussion of implications, conclusions and recommendations.

Promotion of Improved Cook Stoves in Malawi: An Overview

The Government of Malawi (GoM), non-governmental organisations (NGOs), and private and religious institutions in Malawi are promoting ICSs to respond to climate change concerns, deforestation, and firewood scarcity. Climate change and environmental change have emerged as major issues in the country that are severely affecting people's livelihoods.[18] The most serious climate change risks and impacts include prolonged dry spells, seasonal droughts, floods, late onset of rains, higher temperatures, delayed and shorter rainy seasons, increased intensity of rainfall and erratic rains.[19] These have increased in intensity and magnitude over the last two decades.[20]

Some of the environmental risks and hazards experienced in Malawi and local climate change and variability are due to the effects of loss of forest cover.[21] Forests influence local weather patterns and regulate rainfall patterns.[22] Malawi's deforestation rate of 2.8 per cent per year is amongst the highest in Southern Africa and it is accelerating.[23] Forestry reserves declined from 47 per cent to 28 per cent of the country's area in the past 25 years.[24]

However, wood fuel will remain a major source of energy for decades and the major energy resource contributing to total energy demand in Malawi in the years leading to 2050.[25] This is

because the higher energy sources, such as gas and electricity, do not reach the low-income and rural populations, because they are neither available nor affordable.[26] Consequently, the majority of the population depends on wood-based fuels, such as charcoal and firewood, for their energy requirements. The majority of the rural population and nearly half of urban households depend on wood fuel for cooking.[27] Consequently, domestic cooking is contributing to over-exploitation of forests.[28] The energy situation puts pressure on wood and forests, leading to various environmental and socio-economic effects. For example, women walk further distances to collect firewood, which prevents them from engaging in productive economic and household activities and increases their vulnerability.[29,30] Additionally, firewood has become scarce in some parts of the country where some rural households purchase firewood, which has a significant impact on household expenditure.

The high demand for fuelwood in Malawi cannot be met sustainably by the available supply if the majority of households continue to use the Three Stone Fire (TSF) traditional cooking method that has a low efficiency of 15 per cent,[31] which is lower than most common ICSs that are promoted in the country. Despite the range of ICSs promoted in the country, ICSs have the same technical principals, which are responsible for the climate and health benefits.[32,33] The two principals are: (1) improved combustion efficiency, which decreases harmful emissions; and (2) improved heat transfer to the pot, which reduces fuel requirements.[34,35] It is also worth noting that the GoM promotes the provision of low cost technologies for household use, including the ICS,[36] in order to ensure affordability by the poor and rural populations.

Firewood Situation and ICS Practice in Ehlonipeni

This paper focuses on the uptake and use of ICSs in Ehlonipeni, located in a place commonly known as Mpherembe, in Mzimba District in the Northern Region of Malawi. The case study is constructed with participants under Group Village Headman (GVH) Waziloya Makwakwa. It is estimated that there are 36 households under the GVH. At the time of data collection, between 12 and 16 households had an ICS.

The main drivers of deforestation in this area include tobacco-growing, charcoal burning, clearing of land for farming to cater to growing families, and the use of firewood for household cooking and heating. Firewood is moderately scarce. The main source of firewood is a community-owned mountain forest. It takes five hours on average to make one trip to fetch firewood. Participants observed that the forest is diminishing and the distance covered to find firewood is growing, compared to some years back, when there was no need for firewood collection trips, as villagers could collect firewood near the homesteads.

Most houses in the village use TSF for cooking and heating, and only a few households have an ICS. It is estimated that one bundle of firewood lasts for two to three days when cooking on TSF; yet the same bundle would last approximately two weeks when cooking on an ICS. This is because one can cook nsima (Malawi's staple maize-based food) and relish, heat water for bathing and washing hands before taking a meal, with only one sizable piece of wood and small twigs.

The institution responsible for promoting ICSs in the case study site is the Catholic Development Commission in Malawi (CADECOM). CADECOM promotes the fixed type ICS. The cook stove has

three cooking areas. The middle area is large and designed to take family-size pots and other large cooking vessels, for example, for cooking nsima and heating bathing water. The two side cooking areas are designed for smaller cooking vessels, for example for cooking relish. (See Plate 1 below.)

Plate 1: Fixed Stove Promoted in Ehlonipeni

Source: Author, June 2015

To construct the stove, a woman collects all the required materials herself, and then informs the group that has been trained in stove construction to construct the stove in her kitchen. The materials required, their purpose and the quantities needed are detailed in Table 1 below.

Table 1: Fixed Stove Construction Materials

Material	Quantity	Purpose
Ndhulani	1 pail	Cementing ingredient that prevents cracks and ensures the durability of the stove.
Cow dung	2 pails	For retaining heat in the stove.
Grass	1 full 10 litre pail	For holding the ingredients together to make a bond similar to reinforcement wires when making a cement slab.
Ant-hill soil	3 pails	For bonding with other ingredients.

Sand	2 pails	For holding all the ingredients together, as when making cement concrete.
Water		For mixing the ingredients.
Banana tree trunk	1 medium and 1 small sized	For making openings on the stove; space for placing firewood; for directing fire to the side cooking places; for making a chimney.

Sustainability Challenge in Fixed ICSs in Ehlonipeni

The description of the sustainability challenge in this paper is conceptualised from the different ways the concept of sustainability is defined, and from the concept of environmental sustainability. The concept of sustainability has its origins in the United Nations' (1987) Brundtland Commission Report, 'Our Common Future'.[37] The Brundtland Report of the World Commission on Environment and Development defines sustainability as '... development that meets the needs of the present without compromising the ability of future generations to meet their own needs'.[38] Sustainability is also defined as 'the ability to continue a defined behaviour indefinitely'.[39]

Environmental sustainability means, for example, using less energy, and most importantly, development of processes that will lead to a practice or a business becoming completely sustainable in the future.[40] Environmental sustainability falls into three categories: renewable resources; non-renewable resources; and pollution.[41] With regard to environmental sustainability for renewable resources, the rate of harvest should not exceed the rate of regeneration.[42]

The case of sustainability challenge discussed in this paper falls under renewable resources. Ndhulani is a type of soil obtained from an anthill. Ndhulani is replaceable: once it is dug out or disturbed, the ants rebuild, as it serves as their nest. However, since the commencement of the project, which was 14 months old at the time of data collection, only 12-16 ICSs had been constructed in the case study area. It is estimated that there are 36 households. However, ndhulani has become scarce, and women are covering long distances (estimated at 13 to 16 kilometres for a return trip) in their search for ndhulani for stove construction. This is a challenge, as it is enforcing apathy among potential users and slowing the construction of ICSs. It has implications for the growth and sustainability of ICS use. This is because ndhulani ensures the durability of the ICS, and without it, the stove will crack and wear out quickly. In contrast, when using ndhulani the fixed stove can last for five to six years.

An intersection of factors, including addressing the scarcity of firewood and reducing the distance covered by women in collecting firewood, protecting forests and allowing forests to regenerate, and responding to provision of low-cost cooking technologies advocated by GoM, and construction of ICSs, is putting stress on ndhulani. The rate at which ndhulani is regenerating is slower than the demand; hence there is a possibility that the ICS practice may not be sustainable if alternative sustainable solutions are not explored. Therefore, it is the focus of this paper to highlight and analyse the solutions suggested to address the challenge, as envisaged by key actors

involved in social learning about ICS practice in Ehlonipeni, in the search for more sustainable solutions.

Theoretical Framework: Cultural Historical Activity Theory (CHAT)

To engage further with the concern of this study, I considered processes of potential social learning that could address the concern. In doing this, I draw on CHAT, as this is recognised as having the potential to expand learning amongst multi-actor groups concerned with a common object– in this case the successful uptake and use of ICSs in rural areas in Malawi. CHAT was initiated by Lev Vygotsky in the 1920s and early 1930s.[43] It was further developed by Vygotsky's colleague, Alexei Leont'ev,[44] and then later by Engeström.[45]

CHAT is important in this study because it emphasises the role of social, cultural and historical factors in shaping human activity and because it is built on contradictions, reflexivity and agency.[46,47] The three concepts, contradictions, reflexivity, and agency play a major role in influencing and shaping human activity. This paper is concerned with contradictions, defined as 'historically accumulating structural tensions within and between activity systems'.[48] Contradictions take place from clashes within elements of activity system and serve as potential driving force of change, development and learning.[49] 'Inner contradictions can be conscious and result in changes and developments within and between activity systems.[50] The sustainability challenge described earlier, conceptualised as a form of contradiction in ICS practice could help activity systems to find new solutions that may 'effect changes in ICS practice'.[51] CHAT also seeks to influence qualitative changes in human praxis.[52] This could be achieved by allowing members of an activity system to review and revise their ways of doing things,[53] and explicate and envision new possibilities.[54]

'Activity theory has evolved through three generations of research'.[55] This paper focuses on the third generation of CHAT, which provides an opportunity for working with multiple perspectives, as potential sources of learning.[56] This could be achieved through boundary crossing activities, which bring a diversity of activity systems together in a learning process during boundary crossing change laboratory workshops (BCCLWs).[57] The multiple activity systems, which bring multiple perspectives on a shared object (successful uptake and use of ICSs) into focus in this study, are the NGOs practitioners, stove construction groups, and stove users/potential users working with the ICS, which may come together in BCCLWs in order to solve the sustainability challenge described earlier. Activity systems are multi-voiced and it is via this multi-voice engagement with contradictions that learning can occur.[58]

The elements of an activity system in CHAT include the subject of an activity system, which is the individual or group whose viewpoint is adopted.[59] The next is the object, which

refers to the 'raw material' or 'problem space' at which the activity is directed and which is moulded or transformed into outcomes with the help of physical and symbolic, external and internal tools; it precedes and motivates activity.[60]

There are also tools that mediate the object of activity; they can be external, material (for example, a textbook or a computer) or internal, or symbolic, (for example, language).[61] Tools take part in

the transformation of the object into an outcome, which could be desired or unexpected; they can enable or constrain activity. The community refers to the 'participants of an activity system who share the same object'.[62] Another element is the division of labour, which 'involves the division of tasks and roles among members of the community and the division of power and status'.[63] Last are the rules, which are 'explicit and implicit norms that regulate actions and interactions within the system'.[64]

This paper argues for facilitation of boundary crossing, which refers to the process of negotiating and combining ingredients from different contexts to achieve hybrid situations.[65] It is characterised by horizontal expertise, where experts have to move across boundaries to search for and give help, and find information and tools wherever they happen to be available.[66] The term is conceptualised from boundaries, which are defined as 'socio-cultural differences leading to discontinuity in action or interaction'.[67,68] Differences in, for example, norms, knowledge, or power may create boundaries.[69] However, boundaries are sources for learning.[70,71] This is because boundaries compel people to reconsider their assumptions and look beyond what is known and familiar; in so doing, rigidity and routine can be avoided.[72] People, objects and actors from different activity systems can cross boundaries through interactions.[73] The interactions can be established between actors of different practices through facilitation of BCCLWs, during which learning is potentially expanded.

Study Approach and Main Findings

This paper uses qualitative data generated via semi-structured face-to-face interviews and observations within an intensive qualitative case study design,[74] which helped to provide an in-depth understanding[75] of the sustainability challenge within the context[76] of ICS practice in the case study, through seeking relations of connections[77] within the practice. As a formative interventionist researcher,[78] and as is the case with qualitative research, I took account of subjectivity,[79] through practicing reflexivity[80,81] throughout the research process.

Three key activity systems within the ICS uptake process and use case study were identified using the purposive sampling technique, as the study sought to work with actors within the activity systems working on ICSs. First is the disseminating institution, CADECOM; second is the stove construction group; and third is the stove user/potential user activity system. Semi-structured interviews were employed in order to allow participants flexibility to construct their views on reality and think about their situation beyond the researcher's questions.[82] One group interview was conducted with members of the stove construction group; nine individual interviews were conducted with three members from the disseminating institution and six members in the stove user/potential user activity system. This provided 13 participants. The findings emanate from the multivoice perspectives on the uptake and use of ICSs amongst the three activity systems described.

Thematic analysis was employed to analyse qualitative data by: firstly, identifying information on sustainability challenges; and secondly, identifying solutions proposed to address the challenges. Within the challenges, I sought to identify primary contradictions (which refers to a contradiction that is found within an element of an activity system).[83] This led to the identification of the primary contradiction that exists between the need for, and the scarcity of, ICS construction

material, as mediating artefact influencing the uptake and use of ICSs. The solutions proposed to address the challenge include searching for alternative materials and boundary crossing learning.

The findings are divided into two sections. The first section provides evidence of the scarcity of ndhulani and indicates how it is beginning to affect the ICS practice. The second section presents solutions that the research participants proposed to address the challenge.

Scarcity of Material and Implications on ICS Practice

In this section, I present findings obtained from interviews that demonstrate the scarcity of ndhulani and the challenges activity systems are beginning to experience due to the scarcity of material. I also present the implications that this has on ICS practice in the study area.

To begin with, the findings demonstrate that ndhulani is scarce, as expressed by participants from the three activity systems:

> Field facilitator: ... ndhulani we have it, despite that it's so scarce.

> Project officer: ... many people are worried that ndhulani is scarce ... Many people are worried that they have to cover farther distances to find the small one [anthill of ndhulani] to make the mixture.

> Stove potential user: ... I can find all the other materials, but ndhulani is difficult to find ... we searched for it and I did not find it.

> Stove construction group participant 1: ... four people told me that they have started hunting for the soil we are talking about, which is difficult to find in this area.

Additionally, evidence shows that stove construction is putting pressure on ndhulani; the rate at which it is harvested due to the increasing demand for ICS construction exceeds the rate of its regeneration, as demonstrated below:

> Stove potential user: ... I did not find it. Those that constructed the stoves at the very beginning have finished digging it up.

> Stove user: It was not scarce, it used to be found, but since we are many, when you go somewhere, you find someone has already collected it; but when you go farther distances, you will find it; but in surrounding places it is finished, since many of us have constructed stoves.

Further, findings reveal that the scarcity of ndhulani is leading to potential user apathy regarding the construction of ICSs. This also explains the reason why other households do not own an ICS in the study area, as evidenced in the excerpts below:

> Stove potential user: ... it discouraged me, because I did not find ndhulani; so I decided that I should pay those people who know how to construct the brick stove.

> Stove user: ... they lack enthusiasm, since we have to search for the materials for construction of the stove ... they say we have to go far searching for ndhulani, and this discourages them.

> Project officer: ... the long distances people have to cover searching for the soil could be one contributing factor [limiting a person from owning ICS], as people may feel reluctant to cover such distances only to get soil, and they may feel that it is better they continue cooking the same way [on Three Stone Fire].

> Stove construction group participant 1: Some people become lazy to search for the soil ... I was talking about.

> Stove construction group participant 2: ... for some it is really laziness [to construct ICS] and it becomes difficult to go searching for what she is talking about ... the soil called ndhulani ...

In relation to the above (stove potential user and stove construction group participant 2), and as evidenced in the excerpts below, the scarcity of ndhulani is slowing stove construction in the study site, hence affecting the level of uptake of ICSs. Evidence shows that this scenario poses a challenge to the growth and sustainability of ICS practice in the area:

> Stove construction group participant 1: ... if it was plenty, we could have reached 30 stoves in this village; but because the soil is hard to find, we are lagging behind.

> Field facilitator: ... that is why even some people they don't have ... [the stove]

> Project officer: ... with the problem arising from the scarcity of ndhulani, that many people cannot find it, I still think that there will be challenges concerning the soil.

All the three activity systems expressed the scarcity of ndhulani. Findings demonstrate that the rate at which ndhulani is harvested for stove construction exceeds its rate of replacement. Ndhulani used to be found, but it has become scarce after 'many' (16) households constructed

stoves; it can now only be found further afield. Evidence shows that ndhulani is a contributing factor to stove potential user apathy, since people have to cover further distances to find it in order to have a stove constructed. This scenario is affecting the level of stove uptake in the area. Consequently, the scarcity of ndhulani is slowing the growth of ICS practice, by constraining the activity of stove construction as well as use. The stove construction group expressed that if it were not for the scarcity of ndhulani, many households in the area would have had an ICS.

The findings therefore imply that the scarcity of ndhulani is limiting other households from owning an ICS; as a result, it poses as a sustainability challenge to ICS practice in the case study area. The situation as explicated requires exploring alternative solutions through boundary crossing learning processes, more also because the ICS disseminating institution's project officer envisages challenges concerning ndhulani.

Solutions to Address the Material Challenge

This section presents some of the solutions the participants proposed to address the sustainability challenge resulting from scarcity of ndhulani.

Searching for Alternative Materials

The stove disseminating institution activity system indicated that searching for alternative stove construction materials as a solution to the material challenge:

> Field facilitator: ... but alternatively, they can use that from the anthill, [the usual soil from anthills] no problem ... it is like replacing; we do not have ndhulani; you have to increase soil from the anthill. In addition, I have to increase number [amount] of cow dung; but if they do not have cow dung that also is major problem that one.

In the excerpt above, the field facilitator envisages solutions to the challenge using other materials. However, in the last sentence, he alludes to another material challenge that could jeopardise the construction of stoves and the growth of the stove practice, since cow dung is not readily available in the area, as many people do not own cattle. This exacerbates the challenge.

Reflecting on what could be done to address the material scarcity, the project officer had this to say:

> Hence, we were saying should we put a little cement. I felt that one may not afford to buy a little cement for the mixture, it would still be problematic ... and we haven't done any research to find an alternative way.

In the excerpt above, the project officer indicates that she (and probably other practitioners as well), have been reflecting upon the challenges experienced with the material, as well as on what could serve as an alternative material. She reflects on cement, and envisages a barrier relating to the

affordability of cement. Affordability is one factor that needs consideration in the dissemination of ICSs in rural areas of Malawi, as the majority of the rural population live below the poverty line.[84] This is why the GoM advocates the provision of low-cost cooking technologies, as indicated earlier. The project officer's response also indicates the need for research to find solutions to the challenge. This gives impetus to the need for facilitation of social learning processes through BCCLWs.

Solutions with Manifestation of Boundary Crossing Learning

In pursuit of the need to find solutions to the problem of material scarcity, the stove disseminating institution activity system also proposed solutions with manifestation of boundary crossing learning:

> Field facilitator: ... but that one will base on the community themselves, now that ndhulani we cannot find, what can be the alternative way? As I said, if ndhulani it was discovered through the community themselves, so it is like we will go back to the community ... in the absence of ndhulani, which type of soil fill or so can also help?

In the excerpt above, the field facilitator indicates that he would look for the community members to suggest a solution to address the material challenge. He would seek information from the community members, since the knowledge about ndhulani originated from them. In this excerpt, I traced the manifestation of boundary crossing learning: the field facilitator is crossing boundaries from his activity system to seek information and knowledge from another activity system. Another manifestation of boundary crossing learning came from the project officer:

> I was reflecting on this, that if we continue experiencing challenges with ndhulani ... and I asked the field facilitator from Balaka, when we met in Lilongwe, about what could be done, since we have challenges with scarcity of ndhulani.

In the above excerpt, the project officer indicates that they have been reflecting on the problem and have started consulting other experts working within the same organisation, but with more experience on the model of cook stove under discussion. During the interview, the project officer mentioned that they learnt about this model from Balaka. The people from Balaka learnt about it from Uganda. Hence she realises the importance of going back to seek information and tools to continue the cook stove practice in Ehlonipeni. She conceptualises boundaries as having the potential for learning through seeking information and knowledge from other experts.

Implications and Discussion

Implications of Scarcity of Ndhulani on Uptake and Objectives of ICS Innovation

The findings show that the process of replacement of ndhulani is slower than the demand. This is reflected in the scarcity of the material within the first 14 months of the project's inception, with only 12-16 stoves constructed for 36 households in the area under study. Potential users are finding it difficult to find ndhulani. They have to walk long distances (as indicated above) searching for ndhulani. This is a paradox, since one objective of stove dissemination in the area is to relieve women from walking long distances to fetch firewood. The long distances covered searching for the soil is affecting potential users, as they are apathetic regarding stove construction. What complicates this is that they need one full pail of ndhulani to make one stove, but one anthill of ndhulani usually amounts to half of a pail or less. This means that the potential stove user may spend quite some collecting the required quantity of ndhulani. Moreover, ndhulani is just one of the many materials required for construction of the stove (see Table 1). This has implications for the sustainability of this model of a stove in this area, since it is slowing uptake of the stove.

The foregoing scenario poses a sustainability challenge, since many households have to adopt and utilise the ICS in order to ensure sustainable harvesting of firewood, however, the scarcity of ndhulani implies that few households in the area will adopt the ICS. This may have negative implications for achieving the objective of sustainable harvesting and consumption of firewood, and addressing other environmental challenges. The situation calls for a search for alternative sustainable solutions to achieve the objectives for stove dissemination in the area, especially as there appears to be little or no published information on this practice in the ICS context. The suggestion I put forward therefore is facilitation of boundary crossing learning through BCCLWs.

The Role of Contradictions in Resolving the Sustainability Challenge

As indicated earlier, the analysis was guided by the CHAT principle of contradictions. As such, I identified the scarcity of ndhulani, one of the mediating artefacts in the construction of cook stoves, as a manifestation of contradiction. Both the stove construction group activity system and the stove user/potential user activity system require ndhulani to mediate the activity of constructing stoves and of cooking on the stove, respectively. As indicated above, ndhulani is required in stove construction as a cementing ingredient that is responsible for the durability of the stove; however the scarcity of ndhulani is one of main contributors to potential stove user's apathy, and it is slowing the construction of ICSs, which may jeopardise the sustainability of ICS practice. This can be conceptualised as a form of a double-bind. A double-bind is a type of paradox that is a manifestation of a contradiction.[85] The double-bind in the present case is a manifestation of primary contradiction, which is within the element of an activity system[86] (tools). The double-bind is influencing a secondary contradiction that is occurring between the mediating artefact and the subject of the activity in the stove construction group activity system, by constraining the subject

to perform the activity of stove construction (the object). Similarly, it is influencing a secondary contradiction in the stove user/potential user activity system between the mediating artefact and the subject of the activity, by constraining the subject to accomplish the activity of cooking on ICS (the object).

Identification of the double-bind (contradiction) is significant in addressing the sustainability challenge described earlier, since contradictions provide the starting point (before and during BCCLWs) for reviewing tensions and creating opportunities for analysis and problem-solving, during which more learning and meaning making happens.[87] For example, the stove disseminating institution activity system started reflecting and analysing the problematic situation resulting from the identification of a double-bind, as evidenced in the findings above. When contradictions are resolved, learning happens and a potentially more advanced activity system emerges.[88]

Boundary Crossing Learning for Sustainable Solutions

The manifestation of boundary crossing learning in the data gives me impetus to support members from the activity systems to cross boundaries, through BCCLWs, which provide space for boundary interaction,[89] systemic thinking, envisioning, critical thinking and reflection, participation and collaborative decision-making. These skills are key components of learning that bring change for sustainability of an activity, and which are promoted by Education for Sustainable Development (ESD) in addressing environmental and socio-economic problems.[90,91]

In the manifestation of boundary crossing learning from the project officer and the field facilitator, one can see that they are moving across boundaries (activity systems). They are doing this to seek help, to find information and tools[92] from the 'experts' who brought the initial idea to them, in order to find solutions for the material challenge. While both are seeking horizontal expertise, the Project Officer is staying within the organisation – a cook stove disseminating activity system – but in a different practice. The field facilitator is moving to the grassroots, drawing from indigenous knowledge. This is significant, in that engaging communities provides opportunities for working with multiple perspectives, which are potential sources of learning,[93] which may help in finding new sustainable solutions to the material challenge.

Boundaries have learning potential; they can provide a 'chance to explore the edge of your competence, learn something new, revisit your little truths, and perhaps expand your horizon'.[94] Furthermore, 'many scholars have argued that boundaries can be exploited for generative, expansive, and creative processes'.[95] It is also argued that learning at the boundary may lead to the transformation of practices, where new solutions and new ways of working can emerge through developing processes of knowledge sharing and promoting reflection on the practice.[96] This could be facilitated through BCCLWs and the cycle of expansive learning[97] typical of Developmental Work Research (DWR) developed by Engeström.[98] DWR has shown its potential for transformative praxis in southern African environmental education research.[99,100,101,102] However, discussion of the DWR approach and the expansive learning cycle is not within the scope of this paper.

Given the learning potential in boundary crossing, I argue that it is significant that the key activity systems in Ehlonipeni engage in boundary crossing learning processes, as this will

potentially expand learning, from the interactions and from multiple perspectives, to bring new solutions to the material challenge.

Conclusion and Recommendations

In this paper, I have provided evidence that accelerated uptake, utilisation, and construction of ICSs put stress on ICS construction materials in Ehlonipeni. In this case, the scarcity of material identified was that of ndhulani, which is one material used in the construction of the ICSs. Evidence has shown that the rate at which ndhulani is harvested (for constructing ICSs) exceeds the rate of replacement. Ndhulani has become scarce within the first 14 months of the project's inception in the area. I have provided evidence that the situation is contributing to the slow pace of stove construction and jeopardising growth of the ICS practice, since it contributes to potential stove user apathy in stove construction. I have argued that this poses a sustainability challenge to the ICS practice. Furthermore, I have argued that the manifestation of boundary crossing learning in the interview data and the conceptualisation and identification of material scarcity as a double-bind – a manifestation of contradiction within the mediating artefact (ndhulani) – provides fertile ground for the facilitation of boundary crossing change laboratory workshops, and for further expansion of learning and change.

The paper has therefore argued for, and has recommended, facilitation of boundary crossing learning processes in the search for more sustainable solutions to address the material challenge. The paper recommends that the key activity systems in ICS practice in Ehlonipeni should utilise pluralism and diversity in exploring sustainable solutions through engaging in boundary crossing learning processes that have the potential to resolve the contradictions in ICS practice. Nevertheless, due to limitations pertaining to the exploratory nature of the study phase, boundary crossing learning processes were not initiated between key activity systems. There is a need for expanded engagement with participants from the key activity systems.

I therefore recommend facilitation of boundary crossing laboratory workshops between the key activity systems in the next phase of the study. The workshops have the potential to provide participants with the opportunity to analyse their activities and to reconceptualise the problem, in order to find new ways of working within the ICS context, and to find sustainable solutions to the sustainability challenge through a mediated social learning process. In conclusion, it is important to acknowledge that no one can claim a monopoly on wisdom to address sustainability challenges; this requires jointly looking for meaningful, supported and feasible solutions.[103]

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Notes and References

1 Malawi is a landlocked country located in Southern Africa between the latitudes 9° 22′ S and 17° 3′ S and longitudes 33° 40′ E and 35° 55′ E. It is divided into three administrative regions, namely Northern Region, Central Region and Southern Region. It is one of the poorest countries in the world with gross domestic product based on purchasing-power-parity (PPP) per capita GDP of about US$900 in 2010 (World Bank, 2011. World Development Indicators, Washington, D.C.: The World Bank, USA.).

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13 Ndhulani is a type of soil obtained from an anthill built by a certain type of ant.

14 An activity system consists of a group of any size pursuing a specific goal in a purposeful way. It is the unit of analysis in Cultural Historical Activity Theory. (Peal, D. and Wilson, B., 2001. Activity Theory and Web-based Training. In: Khan, B. (ed.), Web-based Training. Englewood Cliffs NJ: Educational Technology Publications, p.147. Available at http://ceo.ucdenver.edu/~brent_wilson/actteory.html, [Accessed 12 October 2015]).

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