

Examining the zone of proximal development in learning and development for climate mitigation

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ABSTRACT

This paper investigates a horticultural community's approaches to developing new farming practices to mitigate climate change induced food insecurity. Drawing on the concept of the Zone of Proximal Development (ZPD) from cultural-historical activity theory, the paper illustrates how the strong cultural and historical attachment to existing practices plays as significant a role as the intractability and unpredictability of the changing rainfalls in mediating community members' investment in new practices. The study suggests what is perceived as 'safe', materially and socially, is playing a central role in setting the boundary of their ZPD.

Introduction

It is often argued that climate change is something that we have to learn to live with because it is an exemplar of a wicked problem: intractable and possibly impossible to resolve (Lehtonen et al., 2018; Peters, 2018). Learning to adapt to climate change has thus become an urgent imperative (Klockner et al., 2018). However, learning must bring change in the way people live and act in the world, and in contexts such as adaptation to climate, change may need to be radical and transformative, the kind of learning and development that Engeström (2001) calls *expansive learning*.

This paper is based on a larger case study that investigated how people in a largely agricultural community in Zimbabwe are learning to adapt their everyday practices in response to climate change. The community is facing a threat to their food and economic security due to frequent crop failures as a result of changing rainfall patterns. In this paper, we investigate the community members' individual and collective responses to this threat as learning and development activities using the analytic resources of cultural historical activity theory (CHAT) according to both Vygotsky (1978) and Engeström (1987). In particular we draw on the concept of the zone of proximal development (ZPD) first proposed by Vygotsky (1978) as:

the distance between the actual developmental level as determined by independent problem solving and the level of potential development as determined through problem solving under adult guidance of and in a collaboration with more capable peers. (p. 86)

This concept is used to explore an individual's potential for development of new understandings: what emerges as possibilities within their proximity of development, why the ZPDs differ from one person to the next, and how community members work together to expand each other's ZPD. However, we are also interested in the possibilities of transformative change in the strongly held beliefs about farming practices by the community as a whole. To understand transformative change in this collective sense, we draw on Engeström (1987) reframing of the ZPD as a collective zone:

It is the distance between the present everyday actions of the individuals and the historically new form of the societal activity that can be collectively generated as a solution to the double bind potentially embedded in the everyday actions. (p. 174)

Both Vygotsky (1978) and Engeström (1987) make a distinction between learning as simply acquisition of new skills and ideas and in Vygotsky's case development, and in Engeström's

case expansive learning. For Vygotsky, development follows learning when the individual has internalized and made meaning of the new knowledge so that they could use this knowledge in new situations. For Engeström, expansive learning is more than the community accepting a possible solution to their dilemma; it is the process of reflecting on and questioning their existing beliefs and assumptions and resolving tensions between the historically established relationships and rules that have sustained the existing practices and the new forms of organization that are needed to overcome the dilemma. It must manifest in new and sustainable practices.

Thus, the paper seeks to investigate expansive learning in a community, and address the questions:

- (1) What is shaping individuals', households' and the community's zones of proximal development of climate change adaptation;
- (2) How do new practices emerge and how is the emergence of these new practices resisted?

Climate change in Zimbabwe and the imperative to adapt

Due to underdevelopment and its geographical location in Southern Africa, Zimbabwe is not only highly vulnerable to climate change but constrained in its ability to respond (Dahou et al., 2012; Davis-Reddy & Vincent, 2017; Fitchett, 2019). In Zimbabwe, like other parts of Southern Africa, climate-induced disasters, especially heat waves, droughts and floods have increased in severity and frequency making agricultural land marginal (Kamara et al., 2018; Knight & Fitchett, 2019; Mashizha, 2019). With an estimated 67% of the population dependent on farming as the major source of income, employment and livelihood (World Bank Group, 2019), changed rainfall patterns have been blamed for exacerbating already threatened livelihoods as crops fail, leading to food insecurity (Abid et al., 2016).

As agriculture sustains the national economy in Zimbabwe (Makate et al., 2019; Nyagumbo et al., 2019), reduced farming productivity becomes a central developmental concern. Rural communities are especially predisposed to climate vulnerability due to systemic flaws in rural development policies which have seen rural communities in Zimbabwe typically characterized by extreme poverty and underdevelopment (Dzvimbo et al., 2017; Kurebwa, 2015; Mutami, 2015). Of particular concern is the limited economic power of smallholder farmers in these rural communities, making other methods of mitigation such as the installation and maintenance of irrigation technologies beyond reach. This leaves 90% of the smallholder farmers in Zimbabwe dependent on rain-fed agriculture, a venture highly vulnerable to climate change (Lunduka et al., 2019; World Bank Group, 2019). Previous studies as well as this study have shown that, while significant strides have been made in seed technologies, the newly developed seeds have been found incapable of coping with the rate at which the climate is changing (Challinor et al., 2016; Setimela et al., 2018). Moreover, the adoption of new seed technologies is low because most smallholder farmers cannot afford them (Fisher et al., 2015).

Learning and climate change adaptation

While a body of research exists in the area of learning for sustainability transformations (change and development of socio-material practices that are environmentally and socio-economically sustainable) (Lehtonen et al., 2018; Mukute et al., 2018), the degree to which learning can drive people to engage with climate change is not yet fully understood (Lotz-Sisitka et al., 2016; Olvitt et al., 2018). Moreover, how climate change education and learning must be

conceptualized, modeled, delivered, assessed and researched to achieve the goals of sustainability is heavily contested across the public, political and academic domains (Lotz-Sisitka et al., 2017; Reid, 2019; Steg, 2018). Climate change education and learning is a new and evolving field that is still undertheorised (Chineka & Yasukawa, 2020; Cutter-Mackenzie & Rousell, 2019; Hess & Collins, 2018).

The impact of climate change is felt no less severely in the Global South than in the Global North, but the number of studies undertaken in the former is more limited (Bhatasara, 2017; Burch et al., 2014; Tschakert et al., 2016, 2014). Moreover, many of the existing models of climate change literacy were developed for formal learning settings targeting mainly school-aged children (Cutter-Mackenzie & Rousell, 2019; Reid, 2019). Studies that focus on the informal learning that occurs in people's everyday practices are rarer (Hess & Collins, 2018; van der Linden et al., 2017). Thus, calls have been made for more context specific research in community learning settings to establish how transformative learning emerge in complex, multi-faceted entities (Lotz-Sisitka et al., 2017).

Such research, though still in its infancy, is emerging in the Global South, including Zimbabwe (see for example, Mukute et al., 2018; Pesanayi, 2016; Restrepo et al., 2018). One approach that such scholars, particularly those from southern Africa have found useful is Engeström's version of CHAT (see, for example, Lotz-Sisitka et al., 2017; Mukute et al., 2018; O'Donoghue, 2014, 2018). CHAT offers a way of analyzing radical and transformative learning that happens in complex, multi-faceted and continuously evolving systems, where what is to be learned is not known (Engeström, 2016; Haapasaari et al., 2018, 2016; Sannino & Engeström, 2017), a description of contexts befitting that of sites where people are struggling to make sense of the impact of climate change.

CHAT based studies of transformative learning in climate-change impacted communities in southern Africa such as those undertaken by Lotz-Sisitka et al. (2017) and Mukute et al. (2018) employed the methodology of *change laboratory*, a model of intervention to facilitate expansive learning processes through a collaborative approach between the researchers and the community members. Our study uses the analytical tools of CHAT without staging a *change laboratory*, and thereby produces insights into the extent to which expansive learning is possible in rural horticultural communities without external scaffolding initiatives, other than the opportunity for reflection offered by our focus group interviews/discussions.

Theoretical framework

Engeström (2016) version of CHAT is known as Third generation cultural historical activity theory^{1,2} and builds on the earlier formulations of activity theory by Vygotsky (first generation) and Leontiev (second generation). For all of these versions of CHAT, the historical and cultural dimensions of learning and development are central. CHAT treats learning as a goal-oriented activity; it uses the term *object* to refer to the goal or motive behind this activity. It provides a lens to examine this activity from the perspective of the *subject or subjects* (rather than the outside researcher) whose actions aimed at achieving their goals are mediated by a range of material and symbolic tools. While Vygotsky's contribution was a socio-cultural theorization of individual's learning and development, Leontiev's later contribution to CHAT was the acknowledgment of the collective nature of many activities, and the need to consider an activity as part of a more complex socio-cultural system. Engeström then developed a representation of this complex activity system with the visual shown in Figure 1.

In this formulation of CHAT, the activity system is treated as the unit of analysis, consisting of, in addition to the *subject(s)*, *objects* and *tools*, the *rules* (for example, policy, legislation, custom and practice), the *community* and the *division of labor* of those involved in the activity, which together mediate the activity.

Learning and development of an activity system is understood to be a response to what

Engeström (2001) calls a *disturbance* to the way that the activity system has been achieving its goals. The importance of the disturbance is emphasized by Engeström for its power to uncover inner contra-dictions within the system that requires resolution in order to successfully manage the disturbance.

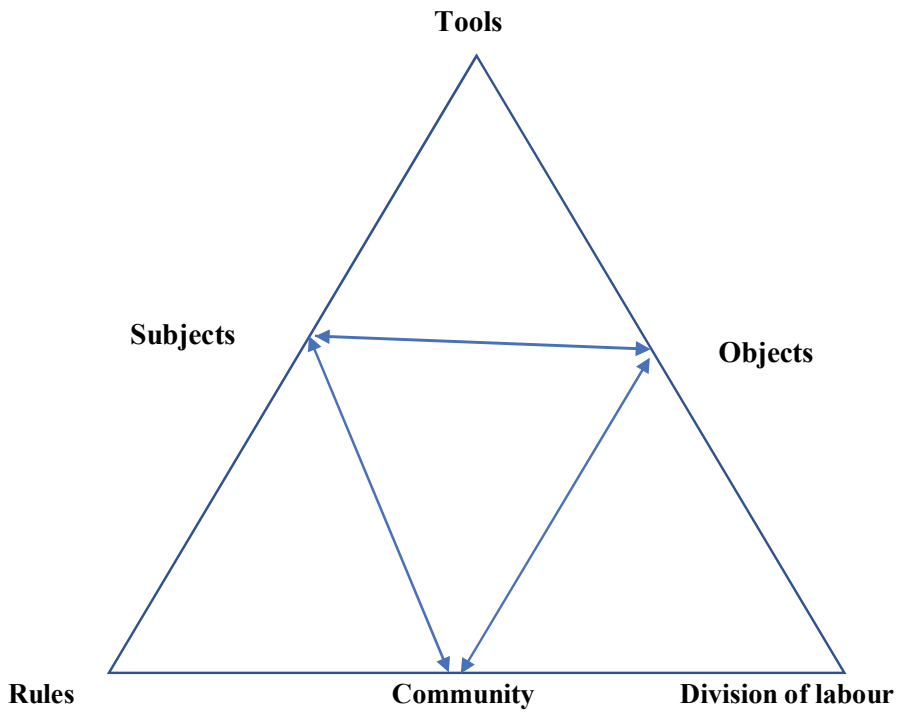


Figure 1. Engeström's representation of an activity system.

The process of resolution may then lead to new arrangements within the activity system, including a revision of what is understood as the *object* of the activity system. When an activity system is radically transformed into a new and sustainable state, *expansive learning* is said to have taken place. As many of the studies using CHAT suggest (Lotz-Sisitka et al., 2017; Mukute & Lotz-Sisitka, 2012; Mukute et al., 2018; Sannino & Engeström, 2017; Vänninen et al., 2015), expansive learning rarely occurs without some form of deliberative formative intervention. Through their studies, cycles of learning actions involving questioning of the current practice, analyzing the situation, modeling a solution, experimenting with the new model, implementing the model, reflecting and evaluating the solution, and consolidating the learning, have been identified as salient features of processes leading to expansive learning (Engeström & Sannino, 2010). The cycles constitute a process of opening up “a radically wider horizon of possibilities” (Engeström, 2001, p. 137). The cycles of learning actions may be seen as processes of a ZPD emerging which in third generation CHAT, Engeström (2016) extends to a collective notion as mentioned in the Introduction.

Several scholars who have drawn on CHAT in workplace learning research (see for example, Kindred, 1999; Roth, 2007, 2008; Yasukawa, 2018) have written about how these constraints and affordances for change are linked to issues of identity and emotion, creating *resistance to change*. Resistance may be due to an ideological conflict between their identities as workers earning a living and their identities as a human resource for their company’s profitability, or emotional reactions, such as feeling of their work (and self) being devalued. While there are many ways in which emotions have been defined and theorized, Holodynski (2013), citing Fijda refers to emotions as “changes in action readiness” (p. 9). Thus, we may consider emotion as playing a part in creating or extending the ZPD in an activity system.

In examining resistance and commitment to learning and development, we draw on the socio-logical construct of investment in learning proposed by Bonnie Norton and her colleagues (Darvin & Norton, 2015) in the context of language and literacy development. Norton developed this construct by building on Bourdieu’s economic metaphors of capital, particularly cultural capital, to draw attention to the socio-historically constructed relationship of learners to the object (in her case, the language the learner is learning) of their learning and their sometimes-ambivalent desire to engage with it (Darvin & Norton, 2015; Norton Peirce, 1995). She argues that this construct enables analysis of how individuals’ commitment to learning may be afforded or constrained by the interaction between their existing and imagined identities and power relations in the social context of learning. While this construct, may not be widely used outside the field of language education, we believe it will help us in our discussion about the ways in which the ZPDs are bounded or opened up for the different individuals and activity systems.

The notion of investment is used to analyze how individuals’ commitment to learning may be afforded or constrained by how their *existing* and *imagined identities* interact with power relations and the way they are positioned in the social context of learning.

Methodology

While climate change could be regarded purely as a scientific phenomenon and studied using the tools and methodologies of the physical sciences, researchers of the sociology of scientific knowledge have argued that what influences adaptation is complex and cannot be construed outside the broader socio-cultural context (Selby & Kagawa, 2018). Cognizant of these arguments, this case study was undertaken using an ethnographic approach, though not

embarking on an ethnography in the way anthropologists traditionally use the term. Rather, the study drew on the tools and methods of ethnography and was guided by the following ethnographic principles: studying people, objects and interactions in their natural setting by collecting data in multiple ways, including participant observation and in-depth interviews, in order to develop thick descriptions of the case (Hammersley, 2018; Pink et al., 2010). This enabled us to examine learning not simply as a technology of the mind, but as what people are able to do (Rogers & Street, 2012), allowing us to observe and to access local meanings and ways of knowing.

The lead researcher's proficiency in the local culture and language enabled the culturally significant meanings embedded in certain expressions and words to be noticed and explored as part of the research. For example, when community members said *gore rino mvura haina kunaya* (which would be literally translated as "it did not rain this year"), we could interpret this as "it did not fall within the expected planting period, so it was *as if* there were no rains." The study thus strengthens the case for ethnographic approaches in research so that the significance of particular language used by the local participants is noticed and interpreted in context; in this case revealing the cultural and historical meanings underlying the participants' voices.

Mutema: case study of a community negotiating the impacts of climate change

The study was purposively located in Mutema, a community dependent on rain-fed farming for their livelihoods, where the impacts of climate change were a cause for concern. Droughts, were not a new phenomenon but of late, had increased in frequency and severity as the weather patterns became so unpredictable that people started to question the wisdom of following conventional farming rules. As a precautionary measure against potential harm that may arise from disclosure of sensitive information, identities of places, families and individuals were anonymized.

The community, Mutema, comprises an estimated 5000 people and shares a common language, Shona. Typical of the Shona tradition, the Mutema community is highly patriarchal; women do not have the same status in the household and the community as men do. These observations confirm other studies which have shown that in both the Global North and South, while women are more vulnerable to climate change, they are not part of the decision-making processes (Ahmed et al., 2016; Mukoni et al., 2018). In these studies, it has been found that adopting innovations proposed by women entails challenging the status quo.

While Zimbabwe gained political independence in 1980, the colonial legacy still lingers (Pesanyai, 2016; Shizha, 2011), including in Mutema. We later discuss more specifically how the colonial legacy influences adaptation, but it may suffice to say here that some of the vulnerabilities to climate change can be traced to colonization. Of significant concern in Mutema and other African communities is how through the socio-engineering machinery of colonization, local cereals, were replaced by maize (Smale & Jayne, 2003), a crop that is maladjusted to the local environment and highly vulnerable to climate change (Setimela et al., 2018).

Compounding that, racial segregation policies of the colonial era confined Africans to rural areas that ordinarily are underdeveloped, drought prone and sometimes marginal (Kurebwa, 2015). The post-colonial government made efforts to redress these imbalances, through upgrading rural service centers into towns and cities (Mashizha & Mapuva, 2018). The study area fell within this category and typical of rural service centers in Zimbabwe, Mutema experienced growth in demand for residential land but with limited industrial development. As previous studies have shown (Mashizha & Mapuva, 2018), unemployment is rife leaving agriculture, a venture highly vulnerable to climate change, as the major or only source of livelihood. While there is piped water and electricity in the community, not every household can afford the installation and maintenance costs. We further discuss how limited access to

resources sets limits to the kinds of adaptations taking place among households.

The site of study was limited to within a kilometer of the local school which served as a convenient center for focus group discussions. Since the intent was to study how people's everyday practices had been changing over time in response to climate change, it was crucial to work with people who had lived in the area for an extended period. Participation was voluntary and participants were recruited through a snow-balling technique where participants were asked to identify further informants through a chain referral process.

Data collection

Data was gathered by the first author over a five-months duration. Three individual interviews lasting on average one hour were held with each participant. Some of the issues discussed were sensitive, for example, how families coped with food insecurity, hence the need to create safe spaces where individuals could freely express themselves without fear of being judged. Additionally, males tended to dominate both focus group discussions and family interviews because in the Shona culture women's voices are subdued (Mapara & Thebe, 2015). It was, therefore, critical to create safe spaces where women could own their voice.

To observe some of the everyday practices, interviews were held in participants' homes, fields, and social spaces such as women empowerment clubs. Typically, women belonged to some religious or kinship grouping where they met regularly and shared ideas and resources to improve their socio-economic conditions. Observations were particularly useful as they provided an avenue for us to identify local meanings (Hammersley, 2018; Pink et al., 2010) in some of the everyday practices. A typical observation that led us to understand the power of convention is how in this community every homestead had a vegetable plot with everyone growing the same crops, but one household defied that logic by growing crops not usually grown in this locale. As the analysis will show, attachment to place and the kinds of crops grown there plays a major role in determining adaptation decisions. Additionally, observations allowed us to notice the extent to which adaptations were similar and different, the physical resources available and the creativity and lack of it among different households. Three focus groups lasting on average two hours were held with all participants to create spaces for the community members to reflect and deliberate on their current practices through engaging them in discussions that sought to unearth what they were currently doing, what they hoped to change, what they had been trying to change but failing and why. Focus groups thus provided additional opportunities for examining what shaped and sustained people's everyday practices and created opportunities for people to build on one another's responses. Part of what this study investigated was how community members could learn from each other about climate change and to examine whether climate change learning and adaptation might be a collectively produced practice. Of interest to this paper in particular and to CHAT in general is how focus groups made visible the power relations between married couples, bringing to light the gender dimensions in climate change adaptation. Even more importantly, the focus groups illuminated the contradictions over the continued growing of maize despite its vulnerability to climate change. Further analysis discusses how some participants regarded the growing of maize as an identity marker while others saw this as a reluctance to challenge convention.

All interviews and focus groups were conducted in the local language Shona, audio-recorded, transcribed and translated into English by the first author.

Data analysis

The ethnographic data was analyzed using the theoretical resources of CHAT. We examined both individuals' development of climate change mitigation practices and the collective development of new practices at the household and community levels. Thus, the focus of

analysis was the relations and interactions between the individuals, their households and the community; none of these activity systems could change without impacting on the stability of the other systems. Although collective action is needed for effective climate change mitigation, the community is not homogenous in their historical connections to the community, the material resources they possess and other forms of power they have within the community. As the analysis will show, this heterogeneity contributes to how a collective ZPD can be established within the community.

In each case, we focused on the responses of the community members to disturbances to different aspects of their activity system, for example, new *tools* that became available to them, new *rules* for planting and farming or new roles within the household. We then analyzed how the participants considered options, and how they were judging what possible change and development they would invest in learning and development within individual households and in interactions between members of different households. The analysis in this paper is limited to interviews, observations and focusgroup discussions with a sample of seven families who had lived in the community for a minimum period of ten years and whose profiles are summarized in Table 1.³

The perspectives of the families, both collectively and individually, were the focus of our analysis using the CHAT formulation of activity systems.

Learning for climate mitigation in Mutema

A number of possible *tools* of mitigating food insecurity had already emerged in Mutema. These included new seed varieties of the staple crop, a different staple crop altogether, irrigation methods and a new schedule for planting. Implementation of any of these new tools has the potential to interact (sometimes in a conflicting manner) with other elements of the activity system, most often the existing rules and the division of labor in place, which can generate new uncertainties. Wadzanayi, a married female in her early forties exemplifies the dilemmas community members dealt with as new tools emerged. Despite growing up in the community, and hailing from a horticultural background, Wadzanayi was confronted with the dilemma of when to plant:

We are caught up in a situation where it seems like we planted too late, probably too early. We aren't reaping significant harvests . . . it appears as if we miscalculated the planting time, who knows. I really don't understand what's going on.

Planting in October has been one of the *rules* in Mutema dating as far back as Wadzanayi and other adult community members can recall because October had been the predictable onset of the rainy season. With the changing rainfall patterns, this *rule* has now lost its rationale. It may need to be questioned because reliance on these “. . . normative, static models of farming systems” (Roncoli, 2006, p. 84), which had served them well, is leading to instances of crop failure. Maize, the crop that is failing, is one that community members regard as their staple crop and to which they express a strong historical and cultural attachment. Ranganayi, a married male in the early thirties, is the family head and breadwinner of the Dehwa household. Ranganayi grew up in the community and expresses his cultural attachment to maize: “Maize is our staple food. You can't afford not to have maize . . . of course you won't die [without it] but it feels like the end of the world.”

Two problems that have emerged in the existing activity system in light of the impact of climate change are highlighted by Wadzanayi and Ranganayi respectively: the rules about when to plant, and the durability of the traditional crop. We focus below on the responses to these problems by different members of the community: securing water, diversifying production, reconfiguring planting regimes, and reducing crop hectareage. We show how these responses bring out issues of creativity, identity and expansive learning.

Table 1. Profiles of the 7 families whose views are captured in the study.

Family name	Participant	Relationship to community
Chimoto	Jerina, widowed female in early fifties; family head and breadwinner	Born and raised in Mutema by farming parents
Dehwa	Ranganayi, male, early thirties; family head and breadwinner	Was born in and grew up in the community and hails from a horticultural background
Dzoro	Danai, female in early sixties. Head of household but eldest son is the family breadwinner.	Born and raised in Mutema and hails from a strong horticultural background
Gwenzi	Tsungayi, family head and breadwinner, husband to Fiona.	Immigrants to Mutema but come from a farming background in their community of origin
Mabasa	Beula, widowed female in her late forties; family head and breadwinner	Immigrants to Mutema but come from a farming background in their community of origin
Makwara	Wadzanayi, female in her early forties. community and hails from	Was born in and grew up in the community of origin
Mhere	Lemuel, male in his early fifties; family head and breadwinner and husband to Lydia	Immigrant family with strong cultural connections with their community of origin

Securing water

Ranganayi recognizes that the continued crop failure presents a risk to their food and economic security. But there is more at stake here: his identity is deeply invested in market gardening because he was “born into” a market gardening family and food production is the means by which he can provide for his family. Thus, a threat to the farm is also a threat to his position and identity as the breadwinner of the family:

As the man of the house, my wife and kids look up to me to provide for them. If a man cannot provide for his family, he risks losing the respect of his children, you risk straining your relationship with your wife.

Importantly too, he is concerned that with repeated crop failure he will not be able to pay school fees for his children. Thus, he is both materially and emotionally invested in introducing innovations:

We were never taught that irrigation helps . . . it was something we learned on our own . . . after we experienced severe hunger. And I said to my wife, . . . let's irrigate or else we will perish from hunger together with our children.

He says, the situation “has ignited creativity in us . . . with knowledge available on irrigation, we have invested in pumps, deep wells ” However, Ranganayi’s innovations are selective. For example, although he knows that maize is highly vulnerable to drought, he will not contemplate a shift to a more drought resistant crop. Instead, he invests in learning and implementing methods of irrigation that will preserve his position in the household while continuing to invest in his existing identity as a traditional Mutema farmer who grows and consumes maize.

Rangayani is not alone in seeing maize as an identity marker. As explained earlier, maize replaced millet and sorghum which had been grown as the staple until the colonization by the British. Although community members acknowledge that the more drought tolerant millet and sorghum offer a sustainable option to maize, they are not willing to grow these indigenous crops. Beula, a widowed female in her late forties explains that “we fear being labeled laggards” should they revert back to their indigenous crops. This suggests that the legacy of colonization in which indigenous knowledge systems and practices were treated by the colonizers as inferior and primitive (Hoppers, 2002; Pesanayi, 2016; Shizha, 2011) continues to hold power over members of the Mutema community and their imagined identities.

There is also another more practical reason why an individual household would not grow millet or sorghum. These grains are susceptible to predatory birds and requires a community wide effort in keeping these birds away, something people are reluctant to do. Additionally, as Danai, a single female in her sixties and head of the Dzoro family who was born in and grew up in Mutema explains: “We continue growing maize even if its failing. It’s less labor intensive. Finger millet is labor intensive. We want things the easier way!” Thus, what is regarded as an identity marker and a source of cultural and historical attachment is itself contingent, in this case on the power of the colonial legacy and on pragmatic reasons. Both however, work to restrict what can and cannot emerge within the boundaries of the ZPD for learning and change.

Diversifying production

The attachment to maize (and the apparent non-negotiability around its place as the staple) is felt by many in the community. Danai, like Ranganayi stresses, “you may eat all these tasty foods like rice but without eating sadza it’s just as good as you haven’t eaten . . . a household without maize is a hungry household.” While maize is an identity marker for Ranganayi, Danai and others who are indigenous to Mutema, preventing investment in an *imagined identity* (Darvin & Norton, 2015) as producers and consumers of a different staple food, this is not the case for all in this community, for example, for the immigrant Mhere family. Married to wife Lydia, and both in their early fifties, Lemuel is the family head and breadwinner of the Mhere family. The Mheres had been farming maize after arriving in Mutema, and like the others, farming had become unproductive. As Lemuel explains:

due to climate change, farming ceased to be profitable and I pulled my children out of school and drove the two eldest girls . . . to go get menial jobs. So, my family was split as a result of poor rains.

His situation has provoked him to experiment with new possibilities. Seeing what was happening, “I was pained, I was aggrieved, I contemplated death.” Not only are Lemuel and his wife Lydia changing their farming methods, but they are also looking beyond farming maize.

We are shifting our focus to orchard farming. It’s better because trees do not need as much water. We irrigate here and there in case of dry spells; we are assured of getting something; with maize you risk harvesting nothing . . . we are raising small animals, rabbits . . . I just acquired two goats. I am slowly turning away from maize . . . as you can see cassava covers a third of my plot . . . it’s a better alternative, drought tolerant and more nutritious than maize [Lemuel].

In communities where cassava is grown for food, it replaces starches such as rice and maize. However, cassava is not commonly grown in the Mutema community, and was introduced by this immigrant family. The value of this imported knowledge was evident in the context of a community experiencing increasing unpredictable rainfalls.

When we came to this community . . . I realised no one was growing cassava. I thought . . . probably this is how they do things here, but I said I wasn't going to follow. I was raised by my grandmother. I saw how she did it and she taught us how to do it. . . . I never imagined it could be this important to me, nor did I imagine doing it myself [Lydia].

For Lydia and her family, maize is not an identity marker, and this appears to afford them with agency to explore new possibilities; learning how to grow cassava was within their ZPD, both emotionally and practically. Until Lydia started to diversify her production, others had and would not contemplate growing anything other than maize. However, now:

many are coming to get the [cassava] seeds. As people pass by our homestead, they see cassava and they ask what plant it is. Some just know the name but don't know what the plant looks like . . . now people know, and some are asking to come and watch how I make the flour [Lydia].

Cassava growing has become visible now not only on the Mhere's homestead but elsewhere in Mutema, for example, at the Gwenzi's, their neighbors. Married to husband Tsungayi and in their early thirties, Fiona of the Gwenzi family is also an immigrant to Mutema who has established a few cassava plants on an experimental basis.

We learn from each other . . . we discuss with Granny [Lydia]; ladies what should we do? Look at what's happening to the rains . . . I got the cassava from Granny just to see how it works . . .

Other studies (Dun et al., 2018; Klocker et al., 2018; Shava et al., 2010) have also found that immigrants can provoke learning in a community by introducing and demonstrating possibilities that until then could not be contemplated by indigenous members of that community. In households close to the Mhere's, what we see is Lydia introducing a disturbance to what has traditionally been the non-negotiable *rule* for achieving food security; a ZPD is emerging through the interaction of Lydia and her neighbors, where Lydia is acting as the more knowledgeable peer supporting the others to develop this new knowledge.

Reconfiguring planting regimes to offset shifting rainfall patterns

Tradition had set October as the onset of the planting period and ordinarily the planting of maize would occur all at once. Because plots have averaged one hectare per household, planting would be completed in a day or two. However, as rainfall patterns have been increasingly unpredictable, some in the community are beginning to notice that planting all at once is risky. Lydia recalls:

the last two years, we grossly miscalculated . . . the last agricultural season deceived a lot of people because it rained and there was a prolonged dry spell. We had planted, the crop germinated [which] grew slightly but withered. It was hot! When it eventually rained, most crops had withered . . . it was too late. Those who planted late harvested better. I planted in one go. This is how I lost it, had I planted again, the second crop might have thrived . . .

One of those who had planted some of her crop later is Fiona who reconfigured her planting regime and staged her planting over a three-month period as a risk management strategy:

it's no longer advisable to plant the whole field in one day. No, you risk losing out; you plant a quarter in October, plant again in November, and again in December, and even in January; I have just realised it's still good. (Fiona).

Until now Fiona had never planted post-December because this was completely outside the custom and practice in Mutema. However, based on her informal studies of rainfall patterns over the last three years, Fiona deduced that unlike in the past, there have been substantial amounts of

rainfall in January. Moreover, the rainy period has been extending to April and this is long enough to sustain the life cycle of maize. Although no formal interventions existed in the community, the felt impacts of climate change on food security and livelihoods were severe, making adaptation an imperative. As Wadzanayi explained:

These days you don't just plant . . . you first evaluate the feasibility . . . food insecurity is discussed wherever and whenever we meet, be it on the way to the grinding mill . . . could be anywhere, these discussions just erupt . . .

Community members had no access to weather equipment, but they received advice from the meteorological department mainly via the radio. They also observed changes in their environment and for Fiona, the levels of water in her backyard well served as a benchmark of how much rain fell in a given year: "it didn't rain this year . . . this is July and my well is already dry. Usually, my water lasts until September/October." While she had not kept a written record of events, Fiona had experienced significant reductions in maize yields: "in a good year, I get up to ten truckloads of maize but over the years, the yields are diminishing . . . this year I doubt if I can get even three [truckloads]." Thus, continued losses in yields led Fiona to critique what she had taken for granted as normal rainfall patterns.

To avoid a likely accusation from her husband of "wasting" valuable resources in a futile experiment, Fiona planted a tiny portion of her land in the previous January period. To her relief, the planting was successful and, "tell you what; I ate that maize last month . . . it's part of the fresh mealies I gave you [Author 1] the other time you were here . . ." Based on the success of the initial trial, both Fiona and her husband Tsungayi are now convinced that planting in January is a possibility after all, to the extent that her husband "wished I had planted a bigger portion." In this household, Fiona's small-scale experimentation had given her husband Tsungayi the assurance that it is safe to plant late, and she has brought a new regime for planting within the proximity of her husband's learning.

However, planting after October, or "late planting" as it is called in this community is not yet accepted as normal practice by everyone. Jerina, a widowed female in her late fifties who is indigenous to Mutema and hails from a strong horticultural background describes how her sister-in-law's late planting, despite its success, invited mockery from other members of the community:

My sister-in-law planted late! It was around 20 December. We laughed [at the time] . . . but then elders always say if you see someone with mental sickness celebrate their success, let them be.

In Jerina's case, however, seeing that her sister-in-law's initiative bore fruit led her to a reevaluation of the norm "So, just plant. Don't say, we have never planted in December."

Reducing crop hectareage to manage risk

There is a shared view among community members that farming in a changing climate is risky business with not only economic consequences but also cost on one's emotional wellbeing. Lemuel says, "farming under the circumstances is a pain . . . planting extensively has become disheartening so you end up planting just a small portion." We see in his remark that part of the learning and adaptation to climate change is managing the risk to one's wellbeing, prompting him to take steps that would risk only a minor disaster than the trauma of losing everything at once.

Small scale planting was supported not only by community members' judgment about what was safe, but also by advice issued by technical experts through the radio. Danai who has taken advice from the experts in the past, has abandoned planting completely after her son had assumed the role of breadwinner.

I didn't plant this year . . . my son who pays for the ploughing told me he was not going to waste his

money because it was announced on radio there won't be any rain this season. But guess what . . . it rained . . . those with good soils . . . are harvesting as we speak right now . . .

Thus, the adoption of new tools, such as advice from the experts, is mediated by the power relations within households. As in Fiona's case where she has to be mindful of the possible criticism about resource wasting from her husband, Danai's ZPD is bounded by what is safe in her own household; upsetting her position in relation to her son does not appear to be an option for her.

Discussion

Climate change and the change in rainfall as well as the need to learn and develop ways of adapting to this change were clearly apparent in Mutema. The study has shown community members noticed the activities of their individual households being disturbed by the uncertainties in rainfall patterns. Although the material practices and consequences to the different households shared similarities (threat to economic and food security), the responses and reconfiguration of their activities were not uniform in kind nor extent. Nor was there a single response among all members of every household. We have shown that the responses included the introduction of new *tools* such as different crops and irrigation systems, and the rejection of well-established *rules* about the timing of planting. What enabled a ZPD to emerge around any of these responses for each community member, their household and community is the subject of the next discussion.

Safety as a defining feature of the ZPD

As discussed earlier, CHAT researchers have identified emotion as an important factor that affords "changes in action readiness" (Kindred, 1999; Roth, 2007, 2008). While the threat to food and income security was the prime motive for changes in action readiness, this was found to be overlaid with issues related to identity and power.

We have seen how the impact of climate change presented a threat to Ranganayi's identity and position in his household. Thus, for him, the impetus for change and development was as much about food security as it was about preserving his sense of identity and position. However, position and power by one member of the household, was seen to also attenuate the scope of change envisaged by others in the household such as for Fiona, who was careful to first experiment with later planting on a very small scale to avoid her husband's anger in case the initiative failed. Both cases have shown that, as Darwin and Norton (2015) had argued in the context of second language learning, the degree of one's investment in learning is mediated by relations of power and identity, and in the case of Ranganayi and Fiona, preserving power relations and social capital was inseparable from what they could contemplate in their learning and development initiatives.

Beyond their own and their household's preparedness for change, any change that could lead to a loss of social capital or ridicule by members of the community was something that evoked caution. Decisions about diversifying their crop, for example, was made not only on the basis of what crops were known to be drought resistant, but on what was deemed socially acceptable. The choice of the drought intolerant maize over the drought tolerant and indigenous grains, millet and sorghum, is a case in point. Growing the latter was associated with being "backward," a historical characterization of those who farmed these crops that the community had inherited from the colonizers who came and introduced maize, the crop to which many in the community regarded as their traditional crop.

However, even with the cultural and historical identification Mutema community members had with maize, learning to grow other crops, such as cassava was not entirely outside the ZPD for all individuals and their households, while still possibly outside the ZPD of the

community as a whole. Although maize remained their preferred crop, in the face of repeated crop losses, a few were prepared to contemplate alternatives. Some participants had lived in the community for over 50 years while others were immigrant families. Although ethnomethodologies such as those that this study has drawn upon focus on the situatedness of everyday practices in the research site, the histories of some of the families in this study have shown that not all the everyday practices can be said to be entirely “local”; aspects of everyday practices in one context can “travel” to other contexts (Brandt & Clinton, 2002; Shava et al., 2010). Some families were importers of knowledge (for example, about crops suitable for being planted) and had introduced innovations to this community that were “foreign” but sustainable, low-risk and have been adopted by the long-time residents of the community, for example, cassava growing.

For the immigrant Lydia, cassava was a safe option because she had seen cassava grown and being eaten in her childhood in her community before moving to Mutema. But for Fiona, growing and accepting cassava as an alternative staple was something new, and which became an option only when cassava growing became more visible in the community and when she could observe and learn from Lydia. Thus, when alternatives are rendered visible and demonstrably feasible and a viable option by some members of the community, a ZPD emerges through interactions with “more capable peers” (Vygotsky, 1978, p. 86).

The study suggests that while individuals, their households and their community experienced a shared disturbance, what each saw as a safe alternative to mitigate against food insecurity was shaped differently not only due to the knowledge they had acquired but because of the different perceptions of risks to what they valued, for example, to their social roles and positions in the household or community and material consequences. Thus, the ZPD, where established was a zone of safety.

Traveling through the safety zone

As discussed earlier, research in sustainability transformations suggests that in order for communities to make sustainable transitions in the face of climate change, they will have to engage in learning of a radical and transformative nature, or expansive learning in CHAT terms. As significant as the motive of learning and change – the threat of food insecurity – was for the community members, each household also perceived new risks associated with change that influenced what emerged for them as the ZPD. Engeström (2016) describes learning and change as a “voyage across the ZPD” (p. 168); however, what we have seen about the nature of this journey would struggle to be called radical or transformative.

Many studies of expansive learning, including the studies by Lotz-Sistka et al., (2017) are based around scaffolded learning, or what CHAT researchers call *formative intervention* (; Sannino et al., 2010). Formative intervention can be understood as a form of scaffolding the cycles of questioning, analysis, modeling, implementation, reflection and evaluation among the members of the activity system managing a disturbance that can lead to *expansive learning* (Engeström & Sannino, 2010).

Our study has found evidence of community members embarking on the action of questioning, certainly at the individual and household levels. A significant focus of questioning was directed at the long-established rule of always planting in October. When October was the onset of the rainy season, there was little reason to question the validity of this rule; however, it had become too obvious to a number of the community members that October was no longer equated with coming of rain and planting in the absence of foreseeable rain risked wastage of seeds and labor. This then led, as we have seen, different households to consider new tools and *rules*, but only those that were “safe” from risks to their identity, status and position within the household and in their community, for their livelihoods. These risks were not mutually exclusive, and we have seen how for Ranganayi certain measures preserved his social position as well as improved his food

and economic security, while other measures that had the potential to improve his food and economic security could bring his identity and reputation in the community to question. Similarly, Fiona found herself weighing up the risk of food insecurity by sticking to the rule of planting in October, with the risk of her husband's anger by experimenting with later planting. Thus, *questioning* was followed by *reflection* which brought into focus the social dimensions of taking or not taking actions for change.

The study did find instances of households modeling changes. These often took the form of cautious, small scale implementation, such as planting on a small area of the land outside the traditional October planting season. It also took the form of learning from the modeling that their neighbors or other family members had provided in their initiatives of planting later or planting a different crop.

Social learning within and between households made learning and change a negotiated and reflective process, but one riddled with tensions as family members did not always agree on what and how to change. Each piece of information and advice carried high stakes and was subject to critical scrutiny, sometimes revealing conflicting risks and benefits about their uptake. There were debates among family members. There were informal discussions among neighbors. These social interactions could also be understood as a process of reflection and evaluation of alternatives to the status quo.

However, the constant watch on the level of acceptance of a possible initiative within the community was also reported to slow down implementation of changes, for example, it took Fiona four years to fully practice "late planting." Thus, while we could see a ZPD emerging within each household for the initiative they were contemplating, we could also see a larger collective ZPD in which the larger community was traveling. These interacted in ways that both constrained and afforded development within the individual household and the community. We also found that in one instance, the opportunity for modeling and implementation was curtailed due to the head of a household unilaterally deciding that planting was not going to go ahead on their land based on information about a lack of rain that he had picked up on the radio.

Conclusion

In this paper, we set out to investigate what was shaping the ZPDs of community members when faced with the need to learn and adapt to the impacts of climate change and to what extent the learning that emerged could be considered expansive. The study showed that even though the whole community experienced the same disturbance to their food security due to changing rainfall patterns – there was not just one activity system that was affected. Climate change disturbed multiple interrelated activity systems, producing what Bateson calls *double binds*, the kinds of dilemmas which "cannot be resolved through separate individual actions alone – but in which joint co-operative actions push a historical new form of activity into emergence" (Engeström, 1987, p. 165). The data suggest that no single activity system could be sustainably transformed in isolation.

This study illustrates that learning to adapt the horticultural practices in a community entails learning and adaptation of household power structures, gender relations within a family, and long-held community assumptions about what was acceptable – as food and as planting practices. Thus, learning and adaptation at all of these levels and in all of these aspects were interconnected, and created the double binds that both presented opportunities for radical transformation of societal norms and traditional practices but also created multiple points of resistance to change. Resistance to learning and adaptation in one area – for example, embracing ideas from outside the community, restricted the extent to which change, and learning could occur in another – for example, experimenting with different crops, making it clear that expansive learning to increase food security was multifaceted.

A necessary condition for investment in learning and change was safety. Just as food insecurity was a risk and the community members were searching for ways to safeguard their food supplies, several of the options including alternate crops, shift in planting time and irrigation presented their own risks, for example, to gender roles and power structures, emotional wellbeing, cultural identity and financial security. Thus, the study has shown that safety plays a significant role at all levels: the individual, the household and the community. Listening and responding to all of these voices is a critical step in building the capacity of the community as a whole to creating and traveling through a shared zone of safety while developing more sustainable practices. This in turn would need to involve understanding the power structures at different levels, historical connections to the community and the availability and distribution of economic resources that can afford agency for some and resistance to others to invest in collective development of mitigation strategies.

The community member's attachment to maize as their traditional crop and as an identity marker revealed the powerful legacy of the experience of colonization. Although maize was introduced and promoted by the colonizers during their rule as a superior crop compared to the indigenous food that had formed their staple diet, community members now regard maize as their traditional diet. This belief is held so deeply to the extent that even putting other factors aside, expansive learning that involved different food sources may be impossible without a communal process of uncovering the internal and external historical and cultural influences of the community members' current practices, the process that CHAT researchers call a genetic-historical analysis (Sannino et al., 2016). Such a process would render visible the range of contradictions that they are struggling to resolve and the interconnections between them, likely uncovering new contradictions to what has emerged in this study as well.

While a more structured and facilitative formative intervention process may lead to the kinds of reflection and analysis leading to expansive learning and a radical transformation in the community's approach to food production, it is questionable that that alone will sustain food security for long. Climate change is an example of what has been called runaway objects, connecting what happens in the rest of the world with what can happen in any particular community:

... objects that are only weakly under anybody's control and have far-reaching, unexpected side effects. [They] are often monsters: they seem to have a life of their own that threatens our security and safety in many ways. They are contested objects that generate opposition and controversy. They can also be powerfully emancipatory objects that open up radically new possibilities of development and wellbeing. (Engeström, 2006, p. 1785)

Food security in a community like Mutema is ultimately bound up with the actions and inactions on climate change worldwide. Mutema is part of a global network of activity systems each confronted by the threat of climate change, or alternatively contributing to that threat. The site of this study could be understood as a microcosm of this global network where its members found making meaning of the changing climate was akin to finding a way through a muddle of compelling, competing and sometimes conflicting conceptions and practices that were mutually incompatible. This poses important questions for formal interventions and collective decision making and action taking when dealing with intractable issues such as global climate change: that across the world, local communities will be struggling to reconcile the increasing failures of culturally and historically meaningful practices to serve their needs. This both exposes the significant obstacles to reaching global and local consensus on actions for global change, while also pointing to the futility of any initiatives to impose changes from the outside that are blind to the cultures and histories of the people who are needing to adapt to change.

Notes

1. Interview transcripts have been translated from Shona to English.

2. Engstrom and Sanino (2021) have proposed a “fourth” generation CHAT (<https://www.tandfonline.com/doi/full/10.1080/10749039.2020.1806328>) which acknowledges the possible limitations of the earlier versions of CHAT to resolve wicked problems. Because climate change is undeniably a wicked problem imbued with uncertainties and conflicting interests from a wide range of stakeholders, the current study may well benefit from examination from the additional lens of the fourth generation CHAT.
3. To protect the identity of research participants, all names used in this article are pseudo names.

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