Implications of the synergies between systems theory and permaculture for learning about and acting towards sustainability

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Permaculture involves the use of principles derived from the operation and organisation of ecological systems to guide the creation of sustainable settlements. This paper is based on the premise that the benefits of integrating the two broad schools of practice and thought in systems theory, namely goal oriented and learning oriented approaches are often overlooked in our efforts become a more sustainable society. Our intent in this paper is to explore the capacity for permaculture to contribute to learning about and acting toward sustainability by facilitating the interplay between these goal oriented and learning oriented approaches. To achieve this we first compare the principles on which permaculture is based with learning and goal oriented approaches of systems theory, as they are applied to the question of sustainability. Our comparison identifies the synergies between many aspects of systems theory and permaculture and provides insight into the importance of interaction between goal oriented and learning oriented systems theory approaches. We then ground these findings in the analysis of two case studies of experiential learning about sustainability through permaculture. The combination of our theoretical and practical exploration illustrates that experiential learning through permaculture offers an important contribution to help us learn about and act toward sustainability.

Introduction

The thinking and practice within systems theory can be seen to fall into two broad schools. One school has been referred to as being dominated by approaches oriented around the goal seeking and the other school has been described as an approach oriented around appreciating, "relationship maintaining" and learning (Checkland 1985). A goal oriented approach contributes to the achievement of objectives and "the search for ends that we already know to be desirable" (in Checkland 1985, p. 759). A learning oriented approach recognizes that goals continually change and "different logics (different actors and outlooks) interact intermittently" (in Checkland, 1985, p. 760) in deciding goals and courses of action. As such this latter school embraces the complexity of the world and the need for inclusion of diverse perspectives, questioning of values, seeking of alternatives and constant renegotiation of what we are doing and why. Both goal oriented and learning oriented approaches have been applied to the challenge of creating sustainability through forms of interaction between humans and between humans and nature that support continuing existence and enhanced wellbeing. The value of integrating goal oriented and learning oriented perspectives has been highlighted by Midgley (2000) in his analysis of different waves of systems thinking that have emerged over the last 50 years[1]. Drawing on Midgley's perspectives, his call for theoretical and methodological pluralism (Midgley, 2000) and the related call for transdisciplinarity in complex situations (eg. Becker 1999; Klein 2004; Lawrence & Depres 2004; Max-Neef 2005), we suggest that an interplay between goal oriented and learning oriented perspectives on systems approaches offers a useful and much needed contribution to enhancing our capacity to learn about and act toward sustainability.

If this interplay offers a useful contribution, the question of how to create this interplay arises. In this paper we explore the potential that the practice and principles of permaculture may have to facilitate this interplay. Permaculture was first conceptualized in Australia in the 1970's by Bill Mollison and David Holmgren

[1] Midgley (2000, p. 214) referred specifically "research communities concerned with intervention" which he identifies as applied science, human relations, psychoanalysis and various offshoots of these fields such as action research, operations research/management science and family therapy. He divided them into three schools along the lines suggested by Habermas: the subjective internal world, normative social world and objective natural world. We consider the latter to be consistent with a goal oriented approach and the internal and social worlds to be aligned with the learning oriented approach.

(Mollison & Holmgren 1978). The focus of permaculturists has been grass-roots change, usually starting with their own backyard and/or community and has flourished through more than 4000 projects across all continents (Permaculture Institute 2000). Permaculture is defined as:

> "*the conscious design and maintenance of agriculturally productive ecosystems which have the diversity, stability and resilience of natural ecosystems*" (Holmgren 2002).

Much of the emphasis of permaculture has been in explaining how to achieve these agriculturally productive systems through certain practices. To a large extent, permaculture has been situated on the periphery of the sustainability debate to date and the potential for the permaculture principles to have broader relevance to sustainability as a whole has been overlooked. This potential is evident in Holmgren's (2004, p. 1) suggestion that:

> "*permaculture is not the landscape, or even the skills of organic gardening, sustainable farming, energy efficient building or eco-village development as such, but it can be used to design, establish, manage and improve these and all other efforts made by individuals, households and communities towards a sustainable future*".

In this paper we examine how permaculture might contribute to the emergence of these improvements toward a sustainable future[2].

First we outline how we see the relationship between permaculture and sustainability. Next we consider permaculture from a theoretical perspective, identifying links between it and both the goal oriented and learning oriented approaches of systems theory. We then explore the practical dimension, through two case studies of the first author's experience. The first focuses on her own learning about permaculture. The second outlines her experience of creating learning experiences for others based on the relationship between permaculture and sustainability.

[2] Ison et al (Ison, Maiteny & Carr 1997) have called for the design of contexts that enable the emergence of sustainable improvements.

The relationship between permaculture and sustainability

Here we clarify the way we envisage permaculture relating to sustainability through the hierarchy of components of permaculture listed in Figure 1. This hierarchy is an adaptation of Robèrt's (2000)[3] "five level model for planning in a complex system" which was expanded on in Robèrt et al (2002) and has become know as The Natural Step (TNS) framework for sustainability.

Permaculture is similar to TNS in that it accepts that there are certain ecological and social constraints[4] which constitute our ecosphere. These constraints are represented in the hierarchy by the highest level of the overarching system. Robèrt (2000, p 248) offers the following examples of physical constraints, which can also be interpreted as physical constraints: the principles of matter conservation, the laws of thermodynamics, the principles of sun-driven biogeochemical cycles and the inability of the biosphere to sustain systemic shifts in its physical parameters. In terms of social principles, Robèrt (2000, p. 248) lists society's dependence on sustainable resource flows and services from the ecosphere. To this highest hierarchical level, permaculture contributes a set of ethical principles which could be regarded as social constraints. The ethical principles of permaculture guide and provide a reference point for the whole practice of permaculture. They are the principles of earth care, people care and fair share (Holmgren 2002, 2004) and in essence these provide the objectives of permaculture practice. We see the ethical principles as overlapping with the second level, which we have modified slightly, labeling it "guiding principles and system characteristics" rather than "principles of sustainability and system conditions".

System characteristics are generally not made explicit in permaculture. However, as we will show later, the design principles of permaculture have many overlaps with

[3] Robèrt's (2000) framework is based on the following five levels
1: the overall system – the ecosphere;
2: principles for sustainability which incorporates four systems conditions and the objectives of sustainability;
3: principles of sustainable development which he defines as the processes required to reach the goals established in level 2;
4: Actions – these are the actions required to apply the principles of level 3 in a way that is consistent with the goals of level 2;
5: Tools: these tools enable monitoring of sustainability from a total system perspective.

[4] Robèrt (2000) and Robèrt et al (2002) use the term principle, rather than constraint, but we have chosen constraint as to be consistent with our interpretation of Robèrt's intent and to avoid confusion with the principles of permaculture.

systems theory and they are essential to learning about sustainability through permaculture. It is from systems theory, particularly as it is applied to complexity, that permaculture draws its implicit system characteristics. In terms of the relevance of the ethical and design principles to sustainability, Holmgren (2004, p. 5) has identified that they are:

> *"applicable to our personal, economic, social and political reorganization….although the range of strategies and techniques which reflect the principle in each domain is still evolving*".

As indicated in Figure 1, it is our view that the design principles of permaculture straddle the second level of "general principles and system characteristics" and the third level, which we have labeled "strategies and processes".

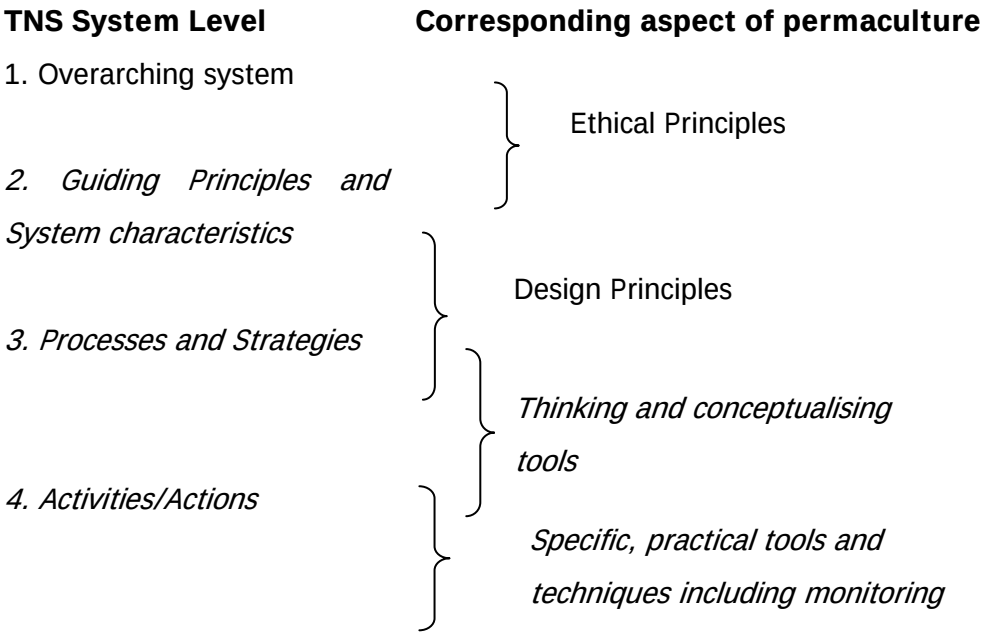

Figure 1: Correspondence of Permaculture to Robèrt's TNS levels

As in TNS, in permaculture, these strategies and processes must be consistent with the guiding principles. In addition to the design principles, the other aspect of permaculture which assists in identifying strategies and implementing processes is a range of what we have labeled thinking and conceptualizing tools. These include tools that highlight relationships between parts of a system (eg. element assembly and element analysis) and mapping tools such as zone diagrams. These tools also

overlap with the fourth level of Robèrt's (2000) framework. The fourth level corresponds to the activities/actions that enable application of the strategies from the previous level in a manner that is consistent with the guiding principles and system characteristics. In permaculture these activities and actions correspond to the vast number of practical tools and techniques that are part of permaculture practice. Examples include anything from passive solar design of houses, to manufacture and use of biodiesel to organic food production and preservation of heritage seed lines. These activities need to be sensitive to the particular agroecological system in which they are applied.

In Robèrt's (2000) framework metrics or tools for measuring the achievement of sustainability occupy the bottom level of the hierarchy. In permaculture however, monitoring is embedded in the principles and in the learning process facilitated by these principles. We therefore propose that permaculture activities required to enable monitoring are already included in the actions level. Consequently we have not included metrics as a distinct level.

We will revisit the hierarchy presented in Figure 1 at a later stage with the purpose of clarifying how it relates to learning and goal oriented approaches. First however, we will provide more background to the learning and goal oriented approaches and how the permaculture design principles relate to these concepts.

Goal oriented and learning oriented applications of systems theory to sustainability

Systems theory is a diverse field with many different perspectives within it (Ison & Schlindwein 2006; Ison, Maiteny & Carr 1997). For the purposes of this paper we identify two broad schools on systems approaches to sustainability: one which is goal oriented and one which is oriented around appreciation, relationship maintaining and learning. The identification of these two schools follows on from the description of systems developed by G. Vickers[5] and championed by Checkland (1985). In our presentation of these schools we will be focusing on their application to sustainability.

[5] Vickers published several books between 1959 and 1983 in which he developed and recorded this thinking (Checkland 1985).

Systems theory and sustainability have been closely inter-twined for over forty years. The beginnings of this relationship reflected the dominance of a goal oriented approach to systems that was prevalent at the time (corresponds to the first wave of systems thinking according to Midgley 2000). Although not typically described as a systems approach, the work of Rachel Carson (1962) provides an example of a goal oriented approach. Many people credit Carson as having initiated the environmental movement which was the precursor to the sustainability movement (McManus 1996). Carson's exposure of the link between accumulations of pesticides and failure of bird's eggs to survive incubation highlighted the systems concept of complex interconnections between different parts, of, in this case, an ecosystem. She also revealed how the human act of creating and using synthetic pesticides had consequences that were not predicted at that time. Her goal was clear – we should stop using these chemicals and not use other chemicals unless we know their impacts. Another example of a goal oriented approach, and one of the most famous applications of systems theory to a sustainability issue aimed to increase the predictability of human impacts on the environment. This was the systems modeling conducted by the Club of Rome which led to the publication of the Limits to Growth report in 1972 (Meadows et al. 1972). The Club of Rome applied systems dynamic concepts to "quantitatively models complex feedback processes and consider[s] impact of change in system relationships" (Midgley 2000, p. 190) in order to predict how patterns of consumption and production and resulting pollution and resource depletion would impact on certain aspects of the environment.

A contemporary systems approach that is more closely aligned to the goal oriented approach than the learning approach is presented by Donella Meadows' use of systems concepts to develop a set of guidelines for identifying what she has called leverage points which are the best places to intervene in a system to bring about change (Meadows 1999). Another influential field, systems ecology, which was founded by H.T Odum and used by Holmgren (eg. 2002) focuses on the study of energetics and metabolism of ecosystems. In its quantitative application, systems ecology provides another goal oriented approach. These examples illustrate how a goal oriented approach is characterised by a fixed objective, often based on a firm idea of what is right and wrong, a strong focus on achieving a certain objective or endpoint and often includes a sense of certainty regarding what is needed to reach this objective.

In contrast to goal oriented approaches, learning or relationship maintaining approaches emphasise learning from the process of moving toward sustainability and negotiation of the paths that are taken. Broadly speaking a learning approach includes the following: valuing of learning (either intrinsically or pragmatically), valuing of multiple perspectives and therefore participation of diverse stakeholders, acceptance of uncertainty and unpredictability and the resulting need for flexibility and adaptability and often the integration of different forms of knowledge. Examples include the work of Bell and Morse (2005a; 2005b) on holism and sustainability therapy, Meppem and Gill (1998) on learning as a key to a trandisciplinary approach to sustainability, social learning for sustainability (eg. Ison, Blackmore & Armson 2003), some approaches to sustainable agriculture and agroecology (eg. King 2006; Röling & Wagemakers 1998), Kay et al's (Kay et al. 1999) ecosystem approach to sustainability, social ecology as promoted by Woodhill and Röling (1998) and Hill (2005) and adaptive management (Gunderson 1999; Jiggins & Röling 2000). Alignment between these approaches to sustainability and the characteristics of complexity outlined in theories of self organization (Kay 2000; Kay & Regier 2000; Kay et al. 1999), non-equilibrium thermodynamics (Prigogine 1997), and network analysis (Ulanowicz 1980) are evident. In addition, perspectives on expertise from post normal science (Gallopin et al. 2001; Ravetz 1999) represent a shift away from a focus on expert knowledge that may characterize a goal oriented approach. We classify the introduction of critical theory into systems theory by Ulrich (Ulrich 1987, 1996) and Midgley (Midgley 1996, 2000; Midgley, Munlo & Brown 2003) to be part of the learning oriented approach (though some might suggest it represents a third school that is oriented around emancipation).

Permaculture has linkages to both the goal oriented and learning oriented approaches of systems theory. The goal oriented aspects encompass the application of permaculture design principles, thinking tools and specific practical techniques to achieve certain objectives such as creation of compost, production of food and provision of shelter. From this goal oriented focus, experiential learning can occur about complexity and interconnectedness through hands on experience and observation of these phenomena as they exist in ecological systems as well as through reflection on the outcomes of using permaculture design principles. Hence a link between the goal oriented approach to systems theory and the learning oriented

approach emerges. We suggest that this link offers an important opportunity for learning about complexity, a system characteristic which permaculture and many contemporary approaches to sustainability are based on. In this paper, our predominant interest is in how the linkage between goal oriented approaches and learning oriented approaches can facilitate understanding and experiential knowledge of complexity and thus facilitate the emergence of sustainable improvements in the interaction between humans and between humans and the environment. The next section of this paper explores these linkages through an analysis of each permaculture design principle from a systems perspective. We then illustrate the importance of these linkages through two case studies of experiential learning about sustainability through permaculture.

Identification of linkages between systems perspectives on sustainability and permaculture

In the analysis of permaculture presented in this paper, we draw primarily on the recent work of David Holmgren (2002; 2004), one of the people who first described the concept of permaculture, together with Bill Mollison. The reason for our focus on David Holmgren's work is that he adopts an explicit focus on elucidating the permaculture principles and how they can be applied to a wider range of situations beyond creating agriculturally productive systems. As such Holmgren's principles provide a clearer basis for illustrating the link between permaculture, sustainability and the goal oriented and learning oriented aspects of systems theory.

Holmgren (2004, p. 6) explains that *"permaculture principles arise from a way of perceiving the world that is often described as 'systems thinking' and 'design thinking'*". In Table 1 we expand on these origins of the permaculture design principles and identify connections between each principle and systems theory and systems approaches. The first column of Table 1 presents each of David Holmgren's design principles, and a brief summary of their meaning. The second column illustrates one way of interpreting the link between the principles and the learning oriented and goal oriented schools of systems theory. To facilitate comprehension of these principles and their connections to systems theory, it is useful to remember the following statement from Holmgren (2004, p. 7)

> *"Each principle can be thought of as a door into the labyrinth of systems thinking. Any example used to illustrate one principle will*

> *also embody others, so the principles are simply thinking tools to assist us in identifying, designing and evolving design solutions".*

The purpose of mapping the principles into learning or goal oriented approaches is primarily to demonstrate how these two approaches to sustainability intertwine in permaculture.

Thinking back to the permaculture adaptation of Robèrt's TNS framework (Figure 1), the mapping conducted in Table 1 highlights how the design principles straddle different levels of the TNS hierarchy. In our mapping of the principles those which have clearly identifiable actions associated with them correspond more to goal oriented approaches. On the other hand, those which are more open to dispute and negotiation and strongly associated with the maintenance of relationships of different kinds have been associated with learning oriented approaches. Direct interplay between the learning and goal oriented approaches takes place within and between principles and the other hierarchy levels of thinking and conceptualizing tools and specific practical actions.

Given the practical sustainability successes of permaculture over the last thirty years, the existence of both learning oriented and goal oriented approaches within permaculture highlights the importance of both approaches for enabling us to act toward and learn about sustainability. This fact was eluded to by Bill Mollison when he wrote:

> *"On one level, permaculture deals with plants, animals buildings and infrastructure (water, energy, communications). However, permaculture is not about these elements themselves, but rather about the relationships we can create between them by the way we place them in the landscape" (Mollison 1991, p. 1)*.

Table 1: Mapping of Learning and Goal Oriented approaches to systems into Holmgren's 12 Permaculture Principles

Permaculture Principle	***Links to goal oriented and learning oriented approaches***
1. *Observe and Interact*: involves taking a step back, questioning what you see, interacting with nature and with each other.	Permaculture aims to "consciously and continuously evolve systems" which are sustainable (Holmgren 2004, p. 1). This principle values diverse knowledges, innovation and flexibility. The attitude of constant awareness, responsiveness and adaptation is consistent with the *learning oriented* approaches to sustainability outlined above. Observation and interaction are also important for monitoring whether goals have been achieved as part of a goal oriented approach. This principle encompasses much of the level of metrics in Robèrt's TNS framework.
2. *Catch and store energy:* suggests that long term investments in resources are desirable (eg. energy sources, soil fertility, water and knowledge).	This principle is, in may ways, a response to dependence of the wealth of our society on fossil fuels and the need for alternative approaches to wealth generation. The importance of a long term focus, use of existing stocks (such as soil, appropriate technological innovation, perennial vegetation) to ensure long term benefits which are part of this principle are reflected in Meadows (1999) leverage points concept. The intent of this principle is quite specific and clear and as such it is most closely linked with *goal oriented* approaches.
3. *Obtain a yield*: take a creative approach to obtain a	This principle is closely linked to the previous one, though it's focus is

Permaculture Principle	***Links to goal oriented and learning oriented approaches***
sustainable yield, match beauty to productivity.	more on maintaining functional and productive environments for the short term and achieving yields in the most effective way, where effectiveness is defined in relation to all the other design and ethical principles. *Goal oriented* approaches are most aligned to this principle.
4. *Apply self regulation and accept feedback*: encourage growth that is appropriate *for* the context, respond and adapt to both positive and negative feedback, maximise the number of self-reliant elements in the system.	This principle is clearly linked to the concepts of positive and negative feedback that are fundamental components of systems theory (eg. Bossel 1998), adaptive management (Gunderson 1999) and self organising systems (Kay 2000). This principle also encompasses the importance of information. As Meadows (1999) has suggested, lack of information is often one of the many limitations of system performance. Increasing self reliance can be regarded as a response to uncertainty and change because it reduces the vulnerability of the system and makes it more resilient. Such a self-regulating system can be likened to a learning system as it is in a state of constant adaptation with the environment. Consequently this principle is most closely linked with *learning oriented* approaches. It also relates to monitoring of goals and therefore has some links to goal oriented approaches.
5. *Use and Value Renewable Resources and Services*: eg.	This principle draws on systems ecology which we have classified as a

Permaculture Principle	***Links to goal oriented and learning oriented approaches***
shade, herbal medicine, fuels, shelter, microclimates and the behaviour and needs of different elements of the system.	primarily goal oriented approach. It suggests that we should draw our income streams from renewable resources whilst regarding our non-renewable resources as capital assets. However, it also introduces the importance of intangible services such as the cultural or spiritual connections that exist between humans and nature. Hence it also consistent with learning oriented approaches' recognition that many important things are not amenable to quantification and that letting things unfold and happen naturally is often desirable. Therefore, this principle has strong elements of both the *goal oriented and learning oriented* approaches.
6. *Produce no waste*: close nutrient cycles, minimise waste, use unavoidable waste productively and conduct timely maintenance to reduce waste generation and unnecessary work.	This principle also draws heavily on systems ecology concepts as well as network analysis (Ulanowicz 1980). It has a clear objective of minimizing waste and closing nutrient cycles and is therefore most closely aligned with the *goal oriented* approach.
7. *Design from Patterns to Details*: recognise patterns in nature and seek to apply these patterns to other levels of the system, engage in overall design incorporating patterns of the land and natural elements such as wind, sun, flood and fire. Consider the big picture while working on the details.	This principle is intimately related to how we use our intuitive knowledge and systemic common sense to make design choices that are consistent with self organizing patterns of life (Holmgren 2004). Hence this principle requires openness and readiness to learn and as such it is most aligned with the *learning oriented* approach to systems.

Permaculture Principle	***Links to goal oriented and learning oriented approaches***
8. *Integrate rather than segregate*: place elements of the system so that each serves the needs and/or accepts the products of another. Ensure that each element of the system serves many functions and that important functions are supported by many elements. Encourage co-operative and symbiotic relationships.	This principles is based on the view that the "connections between things are as important as the things themselves" (Holmgren 2004, p. 14). This view has direct links to the thinking of Vickers (outlined by Checkland 1985) that leads to the original coining of the term *relationship maintaining* approaches, which has since evolved into *learning oriented* approaches.
9. *Use Small and Slow solutions*: take small achievable steps toward your objective, minimise risk, be patient and ensure long term outcomes, not just short term.	This principle refers to taking a long term view and to recognizing uncertainty and avoiding risks that are associated with "big and fast solutions". It is consistent with adaptive management which we have identified as a learning oriented approach but due to its prescriptive nature, we have identified this principle to be *goal oriented*.
10. *Use and Value Diversity*: embrace and work with the tension between variety and possibility on one hand and productivity and power on the other hand.	This principle recognises the creative potential of the tension between different points of view or different states. It is also linked to the concept of resilience which is being applied widely to both ecological and social systems (Boxelaar, Sharma & Paine 2006; Gunderson & Pritchard 2002; King 2006). This principle corresponds to a *learning oriented* approach as it encompasses processes that are dynamic and context specific and not amenable to description in terms of clear goals.

Permaculture Principle	***Links to goal oriented and learning oriented approaches***
11. *Use Edges and Value the Marginal*: explore the edges and periphery of the system for opportunities and valuable contributions not available in the "mainstream".	This principle encompasses both *goal oriented* and *learning oriented* aspects. The goal oriented aspects come with the principles prescription that, for example, the views and knowledge of people who are typically on the fringes and margins should be included. This aspect is closely linked to the boundary critique process which Midgley promotes as part of Critical Systems Thinking (Midgley 2000; Midgley, Munlo & Brown 2003). Inclusion of diverse and previously ignored views facilitates learning through the broadening of perspectives brought to an issue.
12. *Creatively Use and Respond to Change*: recognise that change is everywhere, occurring in different ways on different scales, embrace and use change for system supporting outcomes, be prepared to adapt to change beyond your control.	This principle summarises the essence of management of complex systems that is part of adaptive management (Röling & Wagemakers 1998) and many other *learning oriented* approaches. For example, as Kay et al (1999, p. 725) have suggested "collective striving of many individuals and organizations can lead to large scale structures which are both unplanned and unexpected". This principle also encompasses the receptiveness to and proactive seeking of emergent improvements toward sustainability.

The interplay of the learning oriented and goal oriented aspects is achieved in a powerful way through the practice of permaculture techniques and skills which, as TNS framework illustrates, must be consistent with the ethical and design principles at the higher level of the hierarchy.

In the next section we draw on the theory of experiential learning to explore personal stories of the first author. These case studies focus on learning about sustainability through permaculture, and about using permaculture to encourage learning of others about sustainability. Through these stories we provide examples of the capacity of permaculture to create interplay between achieving practical goals and enhancing our learning about sustainability.

Experiential learning about sustainability through permaculture

In the previous sections we have presented an analysis of permaculture and its relationship to the learning oriented and goal oriented schools of systems theory. We suggested that the interplay of learning oriented and goal oriented aspects of permaculture offers a source of experiential learning about sustainability. In this section we offer two closely related examples of how this interplay occurred as well as how it led to, and could be used to create learning about sustainability as a phenomena in a complex system.

A framework for our case studies is provided by Kolb's experiential learning cycle (Kolb 1984). According to Kolb (1984, p. 33) experiential learning is "a holistic adaptive process". Experiential learning theory assumes that:

> *"ideas are not fixed and immutable elements of thought but are formed and re-formed through experience" and that "..learning is an emergent process whose outcomes represent only historical record, not knowledge of the future" (Kolb 1984, p. 26).*

Experiential learning theory is also strongly influenced by the scientific method (Kolb 1984, p. 32). Therefore it appears that the experiential learning cycle itself incorporates both the dynamicism, adaptability and emergence of the learning oriented approach of systems theory and, through the influence of the scientific method on it's development, the goal oriented approach of systems theory. A modified version of Kolb's learning cycle developed by King (2000, p. 87) and

presented as Figure 2 forms the basis of our approach. This depiction of the cycle conveys more clearly than a closed cycle that the process of experiential learning can lead to qualitative shifts in how and what a person experiences[6]. In using the experiential learning cycle we also are mindful of critiques that state that the steps are not necessarily followed in a linear fashion, but that a learner may jump from one step to another (Infed 2002). Consequently, in our application of the cycle, we do not always follow the path of concrete experience (CE), reflective observation (RO), abstract conceptualization (AC), active experimentation (AE) and another concrete experience (CE).

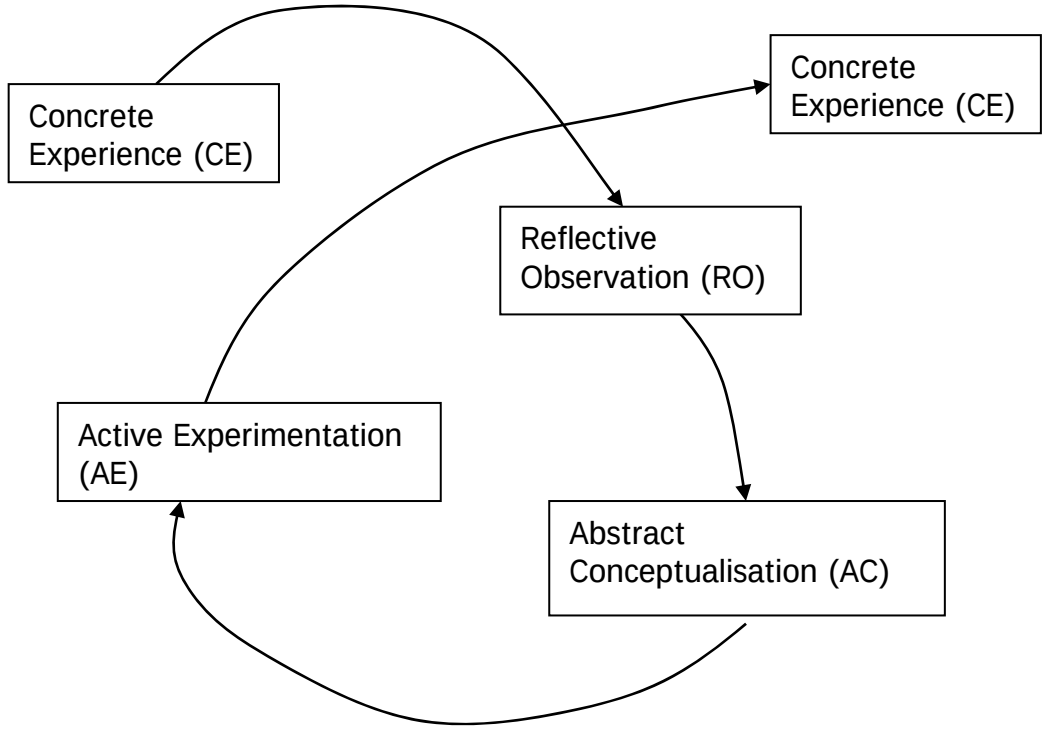

Figure 2: Adaptation of Kolb's Learning cycle presented in King (2000, p. 87)

In this section we will use the cycle in two ways. First we will use it to depict the experiential learning spiral (a series of learning cycles over time) of the first author about permaculture. Secondly we will use the cycle to illustrate a learning cycle which the first author designed to create opportunities for experiential learning about permaculture for participants in her field research[7].

[6] use of a series of cycles to depict learning is quite similar to Dewey's model of experiential learning (see Kolb, 1984, p.23)

[7] Gratitude is extended to the Sir Edward "Weary" Dunlop Fellowship program for funding this field work.

The first author's experiential learning spiral is about the transformation of her perspective on permaculture and how this created an impetus for her research into the potential for broader application of permaculture. Figure 3 below depicts this process. Each event is labeled with an acronym (eg. Concrete experience = CE and so on) to show which stage in the learning cycle it represents. This first author explains the cycle as follows;

My experiential learning spiral starts in 2003 (though in reality it no doubt began at some previous point in my life). At this time I was working in the environmental/community development field in Vietnam and studying international development. Reflection on my experience of the development industry highlighted to me the various shortcomings of current approaches, particularly their tendency to devalue local sustainable practices and to create dependency. At that time, I had a limited knowledge of permaculture. My desire to learn more about permaculture was sparked during a bumpy dusty bus trip through rural Cambodia, driving through an expansive landscape of one small farm after another. During this trip I began to wonder what future "development" had in store for these communities. Permaculture emerged (through an abstract conceptualization) as a potential approach that could avoid devaluing of their local sustainable practices and the creation of dependency on the development industry. On returning from Vietnam I attended a two week Permaculture Design Certificate Course at Crystal Waters which is about a 45min drive from Noosa, Queensland. The Permaculture Design Certificate provided some of the most amazing weeks of my life. The way the course was structured and the lively and challenging conversations with other participants provided the most wonderful learning experience about the theory, practice and broader application of permaculture to sustainability.

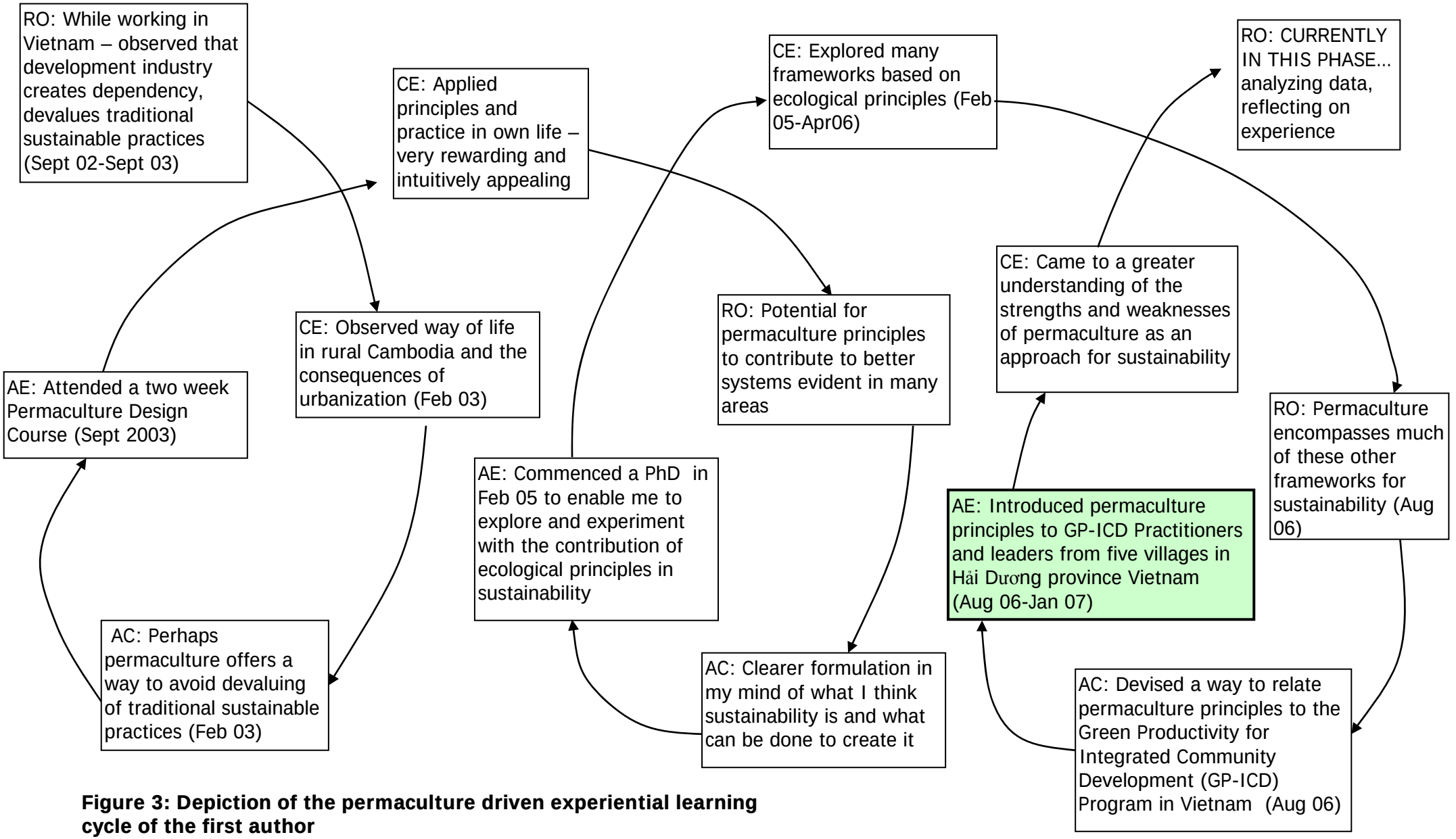

Figure 3: Depiction of the permaculture driven experiential learning cycle of the first author

In terms of the Kolb Learning cycle this course represented a period of active experimentation which encouraged me to then apply the permaculture principles as much as I could in my everyday life. The experience of the course also helped solidify my growing conviction that the principles of permaculture were underutilised in our efforts to create a more sustainable interaction between humans and between humans and the environment. This realization arose through a combination of my technical knowledge of sustainable practices[8], my intuitive yearning for sustainability and from my experience of using permaculture practices to achieve certain goals such as growing food or composting waste. Whilst I had sought these goals before, the permaculture design principles offered the broader context or picture within which these actions fit. I found this both satisfying and exciting.

I began to formulate an abstract concept of how permaculture may offer a framework for sustainability. This led to me to devise a PhD research proposal on the application of ecological frameworks to sustainability which I commenced in February 2005. Although permaculture had been a major influence on my choice of topic, I deliberately avoided focusing on it in my research so that I could be influenced by other ideas and consider a broader range of ecologically oriented frameworks for sustainability[9] In April 2006 I traveled to Vietnam to commence my field work[10] and role of contributing to the continuation of the Green Productivity for Integrated Community Development (GP-ICD) program which I had been involved in when I first worked in Vietnam during 2002 and 2003.

As I was grappling with how to apply the ideas about ecological principles that had emerged from my research in a way that could assist in improving the GP-ICD program I made a "reflective observation" that permaculture principles encompassed all that I was trying to do and the practical track record of permaculture added substance to the theories I was reading. I was faced by constraints of limited time and funds and wanted the funds available to bring maximum benefit for the

[8] This technical knowledge as gained through my experience working as an environmental engineer.

[9] These included ecoliteracy (Capra 1994), a report titled Cities as Sustainable Ecosystems (CASE) (Newman & Jennings 2004), David Korten's living economies concept as it was influenced by Elisabeth Sahtouris (Sahtouris 1999, 2001) and Kay's concept of Self Organising Holarchic Open (SOHO) systems (Kay 2000; Kay & Regier 2000; Kay et al. 1999)

[10] Whilst in Vietnam I was a VIDA (Volunteer for International Development from Australia) in a local NGO called the Centre for Environment and Rural Development.

communities I was working with. The one community with the most experience in GP-ICD had also expressed a desire for new information and ideas. It was in August 2006 when an abstract conceptualization came to me about how to relate the permaculture principles to the GP-ICD program[11] in a way that could adapt to the level of interest expressed by the participants. I set about actively experimenting to determine the validity and applicability of this idea in the context of the group of participants I was working with in Vietnam. This process of active experimentation is now the subject of lengthy reflective observation as I endeavour to make sense of the information people shared with me about their perceptions of permaculture. A key feature of the experiential learning cycles presented in Figure 3 is that over the course of the cycles I felt that my implicit understanding of sustainability became more explicit and this was facilitated and guided by a deepening understanding of the permaculture principles and increasing exposure to the practice of permaculture. In retrospect I now see that the process of active experimentation that I engaged in has many layers. These layers range from a desire to make alternative waste management and farming practices available to participants to a wish to explore forms of implicit knowledge about sustainability and ways to give this implicit knowledge of sustainability a vehicle for expression."

We will now focus on the second case study in which the first authors most recent phase of active experimentation (which is shaded in Figure 3) contributed to an experiential learning process for participants in the research led to co-creation of another learning cycle for participants in her research. There were multiple objectives of this phase of active experimentation, one of the most important was initiating a co-created learning process that included the participants in the field work and the first author. This process is depicted in Figure 4. As in Figure 3, labels AC, AE, CE and RO have been used to indicate the stage of the experiential learning cycle represented in each box.

Participants in this learning process included GP practitioners from the Department of Science and Technology in Hải Dương Province Vietnam and between 25 and 30 people from leadership positions from five villages of five separate districts in Hải

[11] This process was assisted by the opportunity to work with my PhD supervisors on a paper in which we demonstrated alignment between permaculture, systems theory, systems ecology and the UNEP's capabilities framework using a case study from Peru and Ecuador (Smith, Willetts & Mitchell 2006).

Dương province[12]. The learning process revolving around permaculture occurred simultaneously with a learning process about the GP-ICD cycle which was focused on local environmental and productivity issues. The inclusion of permaculture in this process arose from meetings and prior workshops with many of the participants. The participants brought to the workshops their prior knowledge and experience of their own communities and the context in which they live and work. Their willingness to attend and their active participation was indicative of their desire to resolve the environmental problems facing their communities.

Building on this prior knowledge and experience, this learning cycle commenced with an introduction to the principles of permaculture over the course of three separate workshops. A summarized set of four principles were used for this purpose as presentation of twelve principles was considered too detailed for the time available. These four principles were based on Holmgren's 12 principles and additional theory from the other ecological approaches to sustainability that were considered during the first author's learning cycle outlined in Figure 3. The summarized principles were:

- Work with and Respond to Natural Processes
- Observe, be creative and interact
- Value and use resources mindfully
- Be aware of and use linkages and connections

The introduction of these principles was accompanied by activities aimed at encouraging the use of the thinking tools of permaculture and reflective exercises to help participants relate these ideas to their own experience. It became evident that the principle "value and use resources mindfully" had the most meaning for participants and the focus of subsequent workshops was adapted to emphasise this principle. Feedback collected from participants together with comments from participating Hải Dương DOST staff and participant observation during workshops provided the basis of the reflective process of the first author. It became apparent that, for the majority of participants, the permaculture principles were too abstract to be presented on their own and, whilst participants' understanding of the principles did increase over the course of the three workshops, there was a gap between this understanding and ability for people to put the principles into practice.

[12] These villages were Mạn Đê - Nam Sach district, Văn Thai - Cam Giang district, An Thủy - Kinh Môn district, Trúc Lâm - Gia Lộc district and An Dương - Thanh Miên district.

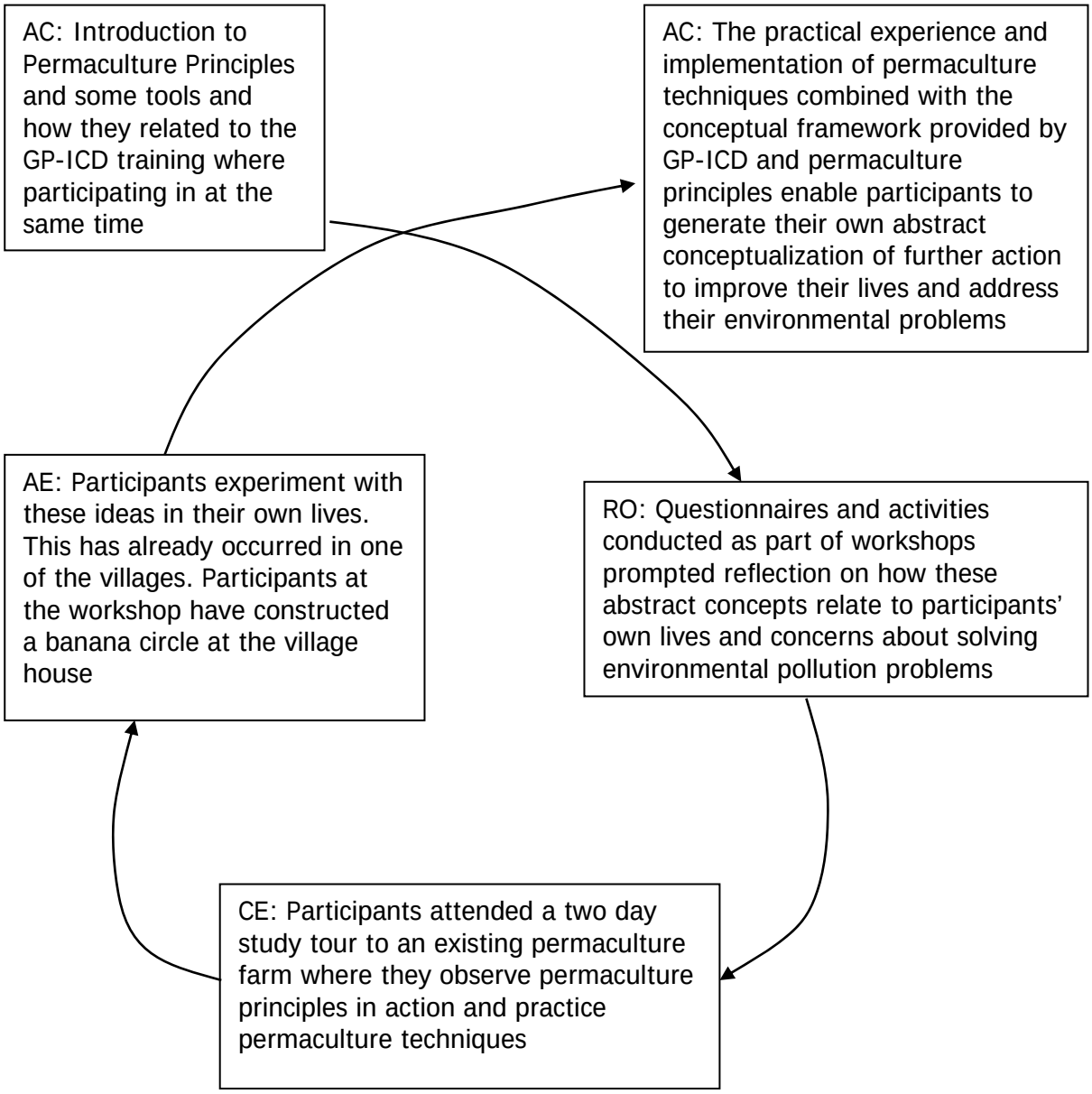

Figure 4: Envisaged experiential learning cycle for participants

Although it was not seen this way at the time, in light of the analysis presented in this paper, this gap could be conceptualized as a lack of exposure to goal oriented approaches which resulted in a lack of grounding for the four principles which we, in retrospect, see as primarily learning oriented principles. The principle of "value and use resources mindfully" provides a slight exception due to its link to many of Holmgren's principles that were classified as goal oriented in Table 1 (eg. Produce no

waste, catch and store energy). Perhaps this link is the reason why this principle had the most meaning for participants. At the time it was decided that the participants needed a chance to experience the principles in action in a real and concrete way. The positive outcomes of this decision combined with the insight regarding the lack of goal oriented approaches in the training highlights an important link between the concrete experience of Kolb's learning cycle and the goal oriented approach that has been discussed throughout this paper.

As indicated in Figure 4, the concrete experience was achieved by visiting a Permaculture Farmer Training Centre which had been set up by a local NGO called SPERI (Social Political Ecology Research Institute). From the responses of participants to the study tour it became evident that the study tour played a crucial role in their understanding of permaculture and provided them with the capacity to actively experiment with permaculture techniques. This experimentation was evident in one village where participants in the Study Tour had built a banana circle for treatment of waste near their village house so that other members of the community could see it. We speculate that, provided the intertwining of the goal oriented and learning oriented approaches has been successful in this learning cycle, participants will be motivated to undertake active experimentation based on their knowledge of permaculture principles and practical techniques. According to Kolb's learning cycle, abstract conceptualisation regarding how permaculture practices and principles relate to participants' lives may follow.

The ultimate hope is that the learning cycle will develop into a spiral in which the participants conceive of and implement strategies that integrate their prior knowledge and experience with permaculture principles and practices to address the environmental problems they face. As one participant observed "permaculture has been in Vietnam for a long time, it just has not been systematic".

Although environmental problems were the focus of this process, there is also scope for this experience to support alternative approaches to social and economic issues as well. Even though we do not yet have information on whether the participants have progressed through the latter stages of the learning cycle, this case study illustrates the potential of permaculture to contribute to valuing of traditional sustainable practices and avoidance of dependency. This potential would be greatly

increased in circumstances were external factors, such as national policy[13] and development agency agendas, are aligned in some way with the essence of permaculture and its principles.

These two examples of experiential learning through permaculture illustrate the importance of interplay between goal oriented activities and learning oriented activities. They also illustrate how permaculture provides a way to learn about and act toward sustainability, through the combination of principles and practical actions and activities that give it substance.

Conclusion

In this paper our exploration has resulted in both theoretical and practical evidence of the potential for permaculture to contribute to learning about and acting toward sustainability. We adopted a modified version of The Natural Step (TNS) framework to represent the hierarchy of ethical principles, design principles, thinking and conceptualizing tools and specific, practical techniques that constitute permaculture. We then identified the goal oriented and learning oriented schools of systems theory and established the linkages between permaculture principles and these two schools of systems theory as they are applied to sustainability. Through this process we illustrated how permaculture creates an interplay between the learning oriented and goal oriented approaches of systems theory, and through this interplay, a connection between all levels of TNS framework. To further demonstrate this we used Kolb's experiential learning cycle to depict two stories of experiential learning about sustainability through permaculture. These stories indicated that the practical dimension of permaculture grounds the hierarchy of ethical and design principles and provides the basis for experiential learning about sustainability through permaculture. As a result of this consideration of theory and practice, we conclude the application of permaculture principles to issues beyond it's traditional application to creation of agriculturally productive systems has the potential to create a form of learning about and acting toward sustainability that is grounded in experience and based on a systems approach.

[13] National policy in Vietnam is likely to constrain or at least strongly influence research participants to adopt agricultural practices which are not consistent with permaculture eg high chemical inputs, monocultures etc

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