Journal of Agricultural Science and Food Technology
Vol. 4 (8), pp. 155-164, October, 2018
ISSN: 2465-7522
Full Length Research Paper
http://pearlresearchjournals.org/journals/jasft/index.html

Transformative learning for sustainability to climate adaptation in a suburban community in the Mekong Delta, Vietnam

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Accepted 11 October, 2018

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ABSTRACT

The study aims to explore the learning process that drives the adoption of techniques and practices for adaptation to climate change (CC) in My Khanh community, Mekong Delta, Vietnam. This community was selected to conduct the study as it represents the entire nexus of CC-water-food-energy-social justice and provides insights into the challenges of transformative learning for sustainability in the Mekong Delta. Transformative learning for sustainability was used to understand the learning process through instrumental and emancipatory learning. Primary data was collected through in-depth interviews, focus workshop discussion, and structured interviews. Descriptive statistics were used to analyze instrumental and emancipatory learning as various adaptation practices and motivating reasons being adopted by farmers. The findings showed all farmers learned instrumentally to some degree: the changes in knowledge and awareness of CC, the effects of a sense of urgency about CC and adaptation, the changes in actions to the effective application of adaptation practices, and the changes in social and economic knowledge. Emancipatory learning was implemented by creating networks and learning interactions. There were several rounds to set up the emancipatory learning among individuals in the community and they were mainly involved to understand values and reasons for locally changing practices.

Keywords: adaptation, learning, climate change, agriculture, Vietnam, transformative learning theory.

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INTRODUCTION

Vietnam is considered as one of the countries most affected by climate change and its Mekong Delta is one of the world's three most vulnerable deltas (together with the Nile Delta in Egypt and the Ganges Delta in Bangladesh) affected by sea level rise (Le Dang et al., 2014a; Le Dang et al., 2014b). The Mekong Delta is located at the southernmost tip of Vietnam and is the site at which the Mekong River empties into the South China Sea. With an area of 39,200 km2, the Mekong Delta accounts for 12% of Vietnam's natural area and 5% total Mekong Basin area (Käkönen, 2008). 22% of the Vietnamese population lives in the Mekong Delta with 412 persons/ km^2 of population density and agricultural land constitutes/occupies 75% of the delta, mainly allocated for rice paddies (Le Coq and Trebuil, 2005).

The Mekong Delta is critically important to Vietnam's national agricultural production (Le Dang et al., 2014b). Can Tho University estimate that the Mekong Delta produces 50% of the nation's rice, 80% of the nation's fruit, and 60% of the nation's fish, dominating the largest agriculture and aquaculture production in Vietnam (ICEM, 2009). Overall, 46% of the total amount of the food produced in Vietnam comes from the Mekong Delta and the Delta contributes 27% of Vietnam's GDP

according to the 2009 Mekong Delta Climate Change Forum Report (ICEM, 2009). Agriculture is the primary livelihood for 60% of the inhabitants of the Mekong Delta (Käkönen, 2008).

With rising sea levels near the low-lying land/area at the mouth of the delta and the (current) increase in rainfall, average temperatures, number of extreme weather events, and saltwater intrusion, climate change has already substantially impacted the Mekong Delta (ICEM, 2009). According to one projection, in the Mekong Delta, 90% of the agricultural land would be affected by flooding and 70% of the Delta will suffer from saline intrusion as a result of climate change (ICEM, 2009). Climate change has become a real threat to agricultural productivity and will negatively impact the local livelihoods, especially of the poor, in the Mekong Delta (Västilä et al., 2010).

The studies of the linkages between food security and production show clearly that in Mekong Delta climate-water-food-energy-social nexus has been affected more seriously than in the past (Bosma et al., 2005; Le Coq and Trebuil, 2005). In this context, local people have great concerns on nexus issues and want to have opportunities to approach different forms of social learning (Hirsch and Lloyd, 2005). The social learning forms include public media, civil society, learning communities, NGOs and academic or training organizations to understand the climate-water-food-energy and social justice nexus and to develop their competence in adapting and overcoming big challenges of climate change and sustainable development (Phuong et al., 2018a). The need for learning and innovation in times of climate change is increasingly recognized in successful adaptation (Adger, 2000; Folke et al., 2003). The occurrence of learning requires collaborative development and knowledge sharing amongst various stakeholders (Armitage et al., 2010) which is vital for coping with climate change (Berkes, 2009).

This study aims to explore the transformative learning for sustainability process that drives to the adoption of techniques and practices for adaptation to climate change. In this study, we applied a transformative learning approach to analyze the learning process and to provide insights into how knowledge flows and (how) the nature of information is conducive to learning. Transformative learning is a compressive model to examine individual learning process for information that can be used to help people overcome barriers to climate change adaptation (Folke, 2006; Mezirow, 1991; Mezirow, 2003; Mezirow, 1997; Taylor, 2017).

Transformative learning approach

Learning is considered an integral element of the resilience of social-ecological systems and prominent features in influential definitions of the concept (Folke, 2006; Folke et al., 2003). According to Mezirow (1996), “learning is understood as the process of using a prior interpretation to construe a new or revise interpretation of the meaning of one’s experience to guide future action”. In this study, learning is understood as the change(s) in knowledge, beliefs, behaviors or attitudes (Keyser, 2000; Wals, 2010). Research about cognitive and emotional processes underlying responses to climate change suggests that individual learning both shapes and is shaped by the frames of reference that determine how people respond to experiences and knowledge of climate change (Wolf and Moser, 2011). In the context of changing climatic conditions, adaptation to respond impacts of environmental changes is considered as a learning process to set up new organizational behaviour (Berkhout et al., 2006).

Transformative learning is a tool used to examine individual learning in adults in different cultural contexts (Illeris, 2018; Mezirow, 1997; Tarnoczi, 2011). It describes the learning in the context that leads to a change in an individual’s frame of reference (Cranton, 1996; Cranton, 2009; Mezirow, 1991; Mezirow, 1997). These frames of reference are the cognitive building blocks supporting the deep changes in values, attitudes, and associated behavior that are central to evolving how people respond to disaster threats, including climate change. Learning outcomes, including transformative learning outcomes, are strongly influenced by their social context and the learner’s capacity to reflect (Phuong et al., 2017a; Phuong et al., 2018a; Sharpe, 2016). Consequently, learning outcomes expressed through values and behavior changes are linked to the experience of learning – who learning is shared with, what is being learned and how this is reinforced.

Transformative learning considers two domains of learning: instrumental learning and communicative learning (Mezirow, 1991; Mezirow, 1997). Instrumental learning focuses on task-oriented problem solving to help individuals improve the performance of their activities and better achieve their objectives (Armitage et al., 2008). Instrumental learning includes acquisition of and insights into ecological, social or economic knowledge, legal and administrative proceedings, possible risks of environmental management and adaptation and risk-mitigation measures (Diduck et al., 2012). On the other hand, communicative learning involves understanding what someone means (Tarnoczi, 2011). It refers to the improvement of people’s ability to understand their own and others’ beliefs, intentions, values, opinions, interests and actions, and to identify commonalities and disagreements (Diduck, 2010; Diduck et al., 2012). In the context of sustainable development, emancipatory learning is explored as communicative learning (Wals et al., 2008). Both instrumental and emancipatory learning consists of critical reflections and critical discourse (Kitchenham, 2008). However, transformative learning often focuses on emancipatory in an active dialogue to establish co-owned objectives, shared meanings, and a joint, self-determined plan of action to make a change (Wals and Jickling, 2002). Thus, transformative learning focuses on the learning process, taking into account the social context in which learning occurs (Diduck et al., 2012; Sinclair and Diduck, 2001). Most research in

transformative learning determines learning outcomes after examining and governing individual's frames of reference (Cranton, 2009; Sharpe, 2016; Taylor, 2007). Nevertheless, this study starts with learning outcomes in terms of change in action and then seeks to examine more deeply the drivers behind the change in action in terms of changes in points of view and habits of mind. The changes in the habit of mind include durable, broad, and habitual ways of thinking, feeling, and acting. Therefore, critical reflection is an important step in altering habits of mind. Points of view, whereas they are continually changing beliefs, values, judgments, attitudes, and feelings that shape interpretation and are the result of culture. Altering both of habits of mind and points of view can lead to a transformation in frames of references, however, only transforming habits of mind is indicative of more fundamental, longer-lasting individual learning (Tarnoczi, 2011). With this understanding, this study uses transformative learning theory as a lens for documenting farmer learning and innovation on the Can Tho city in the linkages between food security and production with the context of climate-water-food-energy-social nexus.

METHODOLOGY

Selection of study site

The research was carried out in Can Tho city in Mekong Delta, Vietnam, which is one of the case studies of the ISSC project on transformative learning identified after field visits in 2015 and 2016. Can Tho, situated in the heart of the Mekong Delta, is the fifth-largest city in Vietnam and is growing rapidly. After 120 years of development, the city now is the delta's most important center of economics, culture, science, and technology. It has a large freshwater port and two industrial parks. Can Tho has advantages not only for agriculture and aquatic products but also for a geographical position that helps development fields such as urban infrastructure, traffic infrastructure, hi-tech agriculture, agricultural–aquatic products and seafood processing industry, tourism and supportive industries. Traditionally being a center of agriculture, forestry and fishery, Can Tho's economy (structure) is increasingly moving toward commerce, service, and construction. Remarkably, climate change is currently a major challenge of sustainable development in Can Tho city. In recent decades, the city has been progressively affected by natural disasters such as floods and storms. Recent studies in Can Tho have indicated that climate change leads to more extreme weather (events) and therefore (negatively) affects food supply, energy and fresh water use and supply as well as social justice.

We have chosen Can Tho city in Mekong Delta as the case study site of transformative learning since it presents the nexus of climate change – water – food – energy - social justice and provides insights into the challenges of learning for sustainability. Additionally, the study site meets the two basic types of learning: instrumental and emancipatory learning. In this study, My Khanh commune is selected for implementing the sub-projects on transformative learning because of three main reasons. Firstly, My Khanh is a typical rural community of the suburban district in Can Tho city. This community is in the process of transforming agricultural mechanics towards sustainable livelihood development in the context of climate change. Secondly, My Khanh community has appeared/established, maintained, and been on expansion and development process of initiatives (germ cell activities) which present possibilities of moving towards sustainability and transformative learning potentials. Amongst various sustainable livelihood models, the VACB model (V-garden/orchard, A-fishing farm, C-livestock farm, B-biogas) is a practical and effective solution for farmers to adapt to climate change. Thirdly, the VACB model has been locally promoted and replicated to other areas in Can Tho and some provinces not only in the Mekong Delta such as Bac Lieu or Hau Giang but also in the central region (of Vietnam) such as Thua Thien Hue or Quang Binh.

Introduction of the VACB model

The VACB model has emerged in Can Tho since the last decades of the twentieth century under the technical and financial support of the Rural Development Project based on the clean development mechanism funded by JIRCAS, Japan. In addition, the VACB also has received the support from the authorities at all levels in Can Tho city through the sustainable development policy in agricultural production. During the exploring process, local farmers explained that "in the last 20 years, the garden-pond-barn-biogas project arose from the collaborations between farmers and scientists and had contributed to household economic well-being". Their main income has come from pig production, garden fruit production, and fish cultivation. They have experienced good environment around their communities, diversified income sources, reduction in energy use, and combination of elements of system production (for example (local) farmers use manure from livestock production for crop production and fish cultivation, water from fish cultivation for crop production and creating humidity for the system production, manure and water from livestock production for creating gas, etc.).

Research methods

The study used both qualitative and quantitative methods for collecting data from September to December 2017. Data collection started with a rapid rural appraisal to gain an overview of the significant social and physical features of the selected study site (Chambers, 1994). A mixture of participatory methods including open, in-depth key informant interviews (n=9), focus workshop discussion (n=35), and structured interviews (n=45) was

used, which allows farmers to participate by sharing their perceptions, experiences, and knowledge in various ways following transformative learning process.

Open and in-depth interviews were used to explore several topics related to the VACB model, climate-related agricultural production, climate risks and (its) impacts, farmers' capacity to deal with environmental changes (climate, market, policies), and planned adaptation measures in VACB model.

The respondents were divided into three categories including learners (called farmers) (n=3), stakeholders (called staff in the projects or local authority) (n=3), and teachers (called trainers or lecturers from university) (n=3). A total of nine respondents were interviewed. The face-to-face interviews (Kumar and Phrommathed, 2005) were also conducted using a structured guide and each interview took about 45-60 minutes.

Focus workshop discussion was organized to explore the concerns and perceptions of learners, stakeholders, and teachers on the difficulties and challenges of implementing and developing sustainable livelihood models (VACB) in response to climate change. Moreover, the workshop also discussed to understand the sharing and reflection of different stakeholders on the role and impact of community learning on the implementation and sustainable development of adaptive livelihood models to climate change in My Khanh commune.

Semi-structured interviews (n=45) were the primary source of data collection. After collecting and classifying information and data from the in-depth interviews and focus workshop discussion, a semi-structured interview questionnaire was designed and implemented. Most questions were closed, however a few open-questions included to allow interviewees to explain (their answers) in greater detail.

The important criteria for selecting the interview respondents are that they have had the VACB model and experienced at least 5 years in crop or livestock production. Each interview took around 30 to 45 minutes. The interview captured the following four topics: characterization of the household, interactions between climate change and sustainable livelihood, sustainable livelihood models, and the roles of community and emancipatory learning.

Data Analysis

Data from the interviews were collected, synthesized, and analyzed using SPSS 22. Descriptive statistics by using number and percentage of respondents were used to present farmer's perceptions of changing climate risks, adaptation practices, sources of information, frames of reference, and indicators of critical reflection and transformative learning.

This analysis was helpful to understand the sense of typology and outcomes of transformative learning as well as the germ cells supporting transformative learning in the My Khanh commune.

RESULTS

Experiential learning as a key factor for approaching and applying the VACB model

The emergence, existence and development of the VACB model's that farmers previously did not know is closely tied to local farmer's experiential learning in which "knowledge" (technical and emancipatory) is created through the transformation of experience (Kolb, 1984). To accept, maintain and develop the VACB as a sustainable livelihood instrument, local farmers in My Khanh have to carry out an experiential learning cycle with the four-stages such as *Experiencing*, *Critically Reflecting the VACB, Choosing to apply an appropriate the VACB model and Actively implement the VACB* (Figure 1).

Learning through different instrumental learning

Transformative learning can be observed by looking into the shifts in the ways of thinking, doing, and re-organizing the production activities of farmers in the community. After long-time of adopting and accessing the VACB model of farmers in My Khanh, we explored the instrumental learning in terms of the changes in knowledge and awareness of climate change, the effects on sense of urgency about climate change and adaptation, the changes in actions to the effective application of adaptation practices, and the changes social and economic knowledge.

Instrumental learning outcomes of VACB farmers in the community involved obtaining local farmers' change in knowledge and awareness of climate change. The majority of VACB farmers (82.6%, n=38) said that their involvement in the extension clubs and the focus group discussions in the training courses or farm visits had at least a modest impact on their knowledge and awareness of climate change impacts on their production activities.

The local extension workers and teachers (Can Tho University) raised questions and we gained a better understanding and knowledge about how temperatures and other things are expected to change. It definitely raised my knowledge level *(a VACB farmer, Truong Thuan village).*

100% of respondents said that they had got information about climate change via television channels. Meanwhile, 76.1% (n=35) said discussing with neighbors and friends, informal talking and sharing had increased their interests in media coverage of climate change and significantly changed their knowledge and awareness of climate change that had impacted their farm production.

The increased knowledge and awareness of climate change or its impacts lead to an increased sense of urgency about adaptation measures in farmers' production activities, particularly in the VACB model (87.0%). Notably, most of VACB farmers (76.1%, n=35) and stakeholders (100%, n=3) said the teachers (

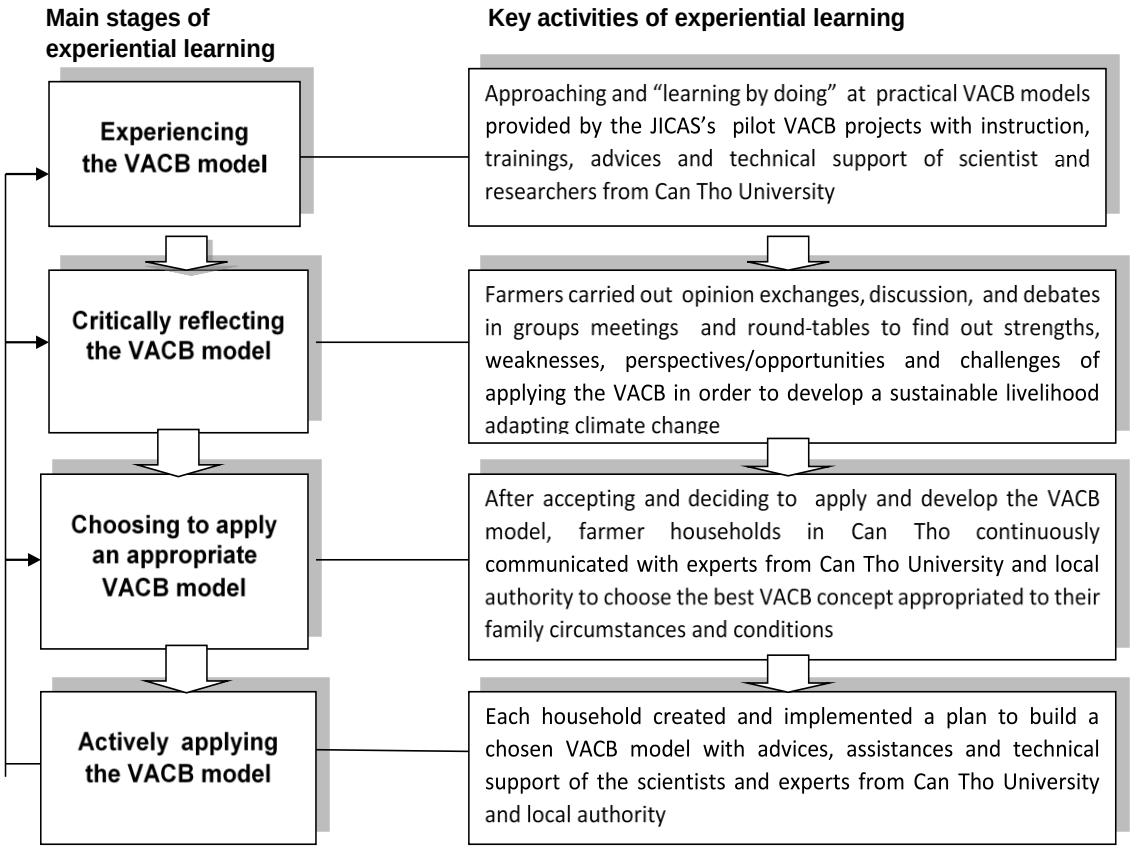

Figure1: Experiential learning cycle to approach and apply the VACB in Can Tho.

scientist) showing them climate change impacts and adaptation measures had directly meant to adjustment and adaptation on their current crop and livestock production. Particularly, 69.8% (n=33) said community learning via group discussions, sharing, informal talking, and individual farm visits predominantly dealt with specific benefits associated with the adaptation practice identified.

I think that climate change has seriously impacted on our farm production. We have suffered severe summers and several climate extreme events in a long timescale which makes it difficult for us to have efficient adaptation measures. Therefore, there is need to be provided or guided more on suitable adaptation strategies for now and the future *(a VACB farmer, Nhon Thanh village).*

Mostly, respondents (69.8%, n=33) reported that participating in traditional training courses had only a modest effect on their views of the changes in effective applying effectively adaptation practices. Great changes were noted through self-learning or sharing experiences and knowledge among learners (scientist farmers) than among teachers or stakeholders. Focus workshop discussion and in-depth interviews indicated that at least ten different adaptation measures are most commonly used or advocated in this community for VACB model (Table 1).

All most all the respondents (91.3%, n=42) adopted the VACB model that is considered as the best way to adapt to the context of climate change. Additionally, local farmers adjusted crop area in their current model to diversify income sources and thereby to reduce risks caused by disease or uncertainty climate during application of integrated production models. Farmers also changed production techniques in VACB model to adapt to climate change such as adjusting the timing and quantity of chemical fertilizer and pesticide application, using more manure, and altering crop density. Under the support from NGOs, organizations, and annual plan of the Department of Agriculture and Rural Development at the district level, the participation in the training courses supported local farmers to apply techniques to crop rotation model and to adjust crop season calendar. Interestingly, applying techniques in save-water, applying drought-tolerant crops/livestock, finding alternative livelihood (migration), and applying salinity-tolerant crops are four measures to be hardly adopted.

Table 1. Adaptation measures to climate change for VACB model.

SN	Adaptation measures	Application
1	Applying VACB model	91.3% (n=42)
2	Adjusting/changing the crop patterns	78.3% (n=36)
3	Applying the integrated production models	56.5% (n=26)
4	Applying production techniques to adapt to climate change in VACB model	37.0% (n=17)
5	Adjusting crop season calendar	21.7% (n=10)
6	Applying technique in crop rotation to reduce diseases risks	21.7% (n=10)
7	Applying techniques in save-water	15.2% (n=7)
8	Applying drought-tolerant crops/livestock	15.2% (n=7)
9	Finding alternative livelihood (as migration)	13.0% (n=6)
10	Applying salinity-tolerant crops	2.2% (n=1)

Table 2. The main factors to motivate farmers adapting adaptation measures.

SN	Main factors	Responses
1	Economic cost-benefit ration	87.0% (n=40)
2	Changes in market price create new opportunities	82.6% (n=38)
3	Changes in weather and climate	69.6% (n=32)
4	Local support from stakeholders	47.8% (n=22)
5	Legislation and policies to adopt a particular measure	26.1% (n=12)
6	Changes in life environment	19.6% (n=9)

During group discussion, local farmers argued that these measures were the responsibility of scientists, except (for) migration measure. Therefore, instrumental learning outcomes associated with this practice were reducing the amount of chemicals used, maintaining productivity (income) under uncertainty climate, conserving soil moisture, and diversifying the farming operation.

There were three main types of learning: self-learning and self-thinking, community learning, and training. Every local farmer has learnt via self-learning such as reading of books, newspapers or technical handbooks, self-watching television, self-listening to radio, self-enrolling in training courses, and self-reflecting through personal experience. Several farmers have learnt via community learning such as their daily activities, neighbours, community meetings, extension club meetings, successful pilot demonstrations, and mass media (commune loudspeakers). Whereas some have learnt via training from university and institutes such as training courses, visiting tours, and support from extension workers or researchers. These learning ways/channels play an important role in enhancing local farmers' capacity to respond to climate change impacts and fluctuating market conditions. Informal or self-learning is a significant way in which farmers work towards solutions to their concerns. Formal learning (courses from university and institutes) has provided the basic and science knowledge for key farmers who are the most important actors for expanding learning in the communities.

Several farmers indicated that they learned benefits only after the adaptation practice in the question adopted. Results from group workshop discussion showed that they often learned economic benefits of the practice leading to their adoption initially. During applying VACB model and transformative learning process, 78.3% (n=36) of respondents knew and understood that environmental benefits are critical for ensuring the economic benefits in the long term. However, currently, environmental benefits were not usually the only factor driving the change. Economic benefits (87.0%, n=40) and market price (82.6%, n=38) were considered the primary reasons for the change in practices, while the environmental benefits were secondary (Table 2).

In addition, the social knowledge, particularly social networks and social trust, are/is very important to both individual and collective benefits. All of the respondents reported that they had more relationships with other farmers in the community and also connected to other networks. The support of both knowledge and financial from Can Tho University's scientists and the conscientiousness of local extension workers and learners (scientist farmers) created trust among people in the community. Particularly, through communication such as information sharing and talking with other farmers, local farmers accessed more information and had new contacts of consultation for improving further their agricultural production.

Emancipatory learning through creating networks and learning interactions

Emancipatory learning in the My Khanh community was implemented by creating networks and learning interactions. There were several rounds to set up the emancipatory learning among individuals in the

community. Emancipatory learning, in this case, was mainly involved in understanding values and reasons for changing practices.

The first round of emancipatory learning involved the scientists of Can Tho University, the researchers of the CDM project (Clean Development Mechanism) and JIRCAS project (Japan International Research Center for Agricultural Sciences), and local authority (DARD, DONRE, DAE, CBOs, social civil groups). The aim of this emancipatory learning is to establish the local team including the researchers of Can Tho University and the key informants in the community to create networks and learning interactions among different stakeholders and the VACB farmers. The purposes were primarily to understand and explore the research contexts and matters of concern in the region. These participants were already familiar with the concept of learning community or continuous learning, therefore it is not difficult to encourage networks and mapping learning interactions via email, Skype, Facebook, or mobile phone.

The second round emerged is formed during the first round of learning interactions and mostly took to understand and to find the appropriate solutions to climate change adaptation. The networks of teachers and stakeholders, including key farmers in My Khanh community (called “scientist farmers”) who were trained and self-studied to be the trainer of VACB model for other farmers and scientists from Can Tho University and attended the transformative learning activities in the communities. The case of the “scientist farmers” is considered a good germ cell for emancipatory learning in transformative learning. This germ cell develops well and spreads learning activities to the application of adaptation measures in the community in the climate change context. There were several informal talking and participatory observations among scientist farmers and other farmers in the community to deeply understand their matters of concern and adoption of the practical adaptation measures. The success of these “scientist farmers” and their innovations is important to the contextual profile for expanding learning and sharing. Furthermore, they serve the function as a field classroom where people can learn about the technology or exchange their knowledge and experiences. In addition, the second round of these learning interactions also has added the participants for the networks.

All of us together watch and share what we do. People keep track of what one does and observe what is working. We are also visiting demonstrations to a certain extent looking for better ways to do things. If any person in the community has something (new), every person in the community will watch and discuss together wherever we can get such as on the road, in coffee shops, wedding parties, local markets, etc., *(a VACB farmer, Truong Thuan A village).* Most of my knowledge would gain from a couple of neighbors, and I follow their experiences when they have a successful demonstration. *(A VABC farmer, Truong Tho 2 village).*

Although emancipatory learning among farmers in the community is important, however the third round of learning through the interactions among “scientist farmers” and agriculturalists (teachers) is also critical to improve and increase new knowledge as well as build trust together.

The extension workers at the district level and agricultural staffs at commune level were kinds of a consultant who knew a bit about everything but kind of had specialties in different areas. Interestingly, he also provides some insights into adjustments in the case of absence of training courses or dialogues. *(A VACB farmer, My Phung village).*

The most important of emancipatory learning among farmers and other stakeholders is emphasized after co-defining the matters of concern. It focuses on finding the solutions to techniques for climate change adaptation in relation to the production system and marketing issues that the farmers have been facing. Therefore, emancipatory learning in the third round is important to find appropriate solutions or measures to adapt to the changes of climate and market.

The solutions were co-developed including stabilizing the market, training how to use the finance efficiently, supporting climate change adaptation policies through adaptation strategies and finance, learning community via cooperative and collaborative production (inputs and outputs – market issues). I think that emancipatory learning should emphasize dialogues among “scientist farmers”, agricultural extension workers, and facilitators (from universities) for transforming knowledge, techniques, and experience in VACB model and how to enable social learning for farmers and other stakeholders (An agricultural extension workers, My Khanh commune).

Critical reflection

The learning interactions of the climate change issues

“*I feel that it is almost twice hotter than it was ten years ago*”, Mr. Liem, a 58-year-old farmer. While Mr. Man, a 57-year-old farmer, stated that “*Climate change has happened, I can feel it. Last ten years ago, our community did not have salinity in the river, but over the last two years, the salinity often comes in the summer season. This has created several difficulties for watering my orchards. In addition, I have grown the orchards for a long time, however, in recent year, the temperature and humidity are changing and result in more serious diseases*”.

The learning interactions of the environment in the community

Some attendees agreed that environmental degradation had become an emerging danger threatening their life

and source of water supply – mostly this came from the waterways crossing their village.

"In the past, we could drink water directly from rivers or pools while working in the rice fields. But recently, as you see, the rivers are so dirty and heavily contaminated that we have to stop using it, even for irrigation," Mrs. Minh said.

Mr. Hai, the commune official, responsible for agricultural affairs, added that the main sources of pollution basically come from industrial and agricultural activities. "*While local authorities are trying to stop those emitters, local farmers are now exploiting groundwater for household use and irrigation."*

The learning interactions of the adaptation measures to respond to climate change

"*Diversifying income sources is a critical strategy to ensure the sustainable livelihood for my family. That is why I have applied the VACB model. This model was encouraged by Can Tho University and local authority*", a woman said. *"In the past, only one kind of fruit was grown in my garden, orange for example. As market conditions are now fluctuating and climate has been very uncertain, more than five kinds of fruit are growing. The disease and insect have increased due to the changes in temperature and humidity, therefore I must have some adjustments in my garden. I have learnt these strategies from Mr. Hai Thanh"*, Mr. Binh said.

The learning interaction about the main roles of facilitators in facilitating the transformative learning for sustainability

The facilitators play the main role in facilitating the transformative learning interactions through creating the networks between learners, teachers, and stakeholders. The facilitators also create opportunities for learning interactions to be taken place.

"At the beginning, we mediated the learning processes and interactions during the initial meetings and created the network, but this role was shared with the local team and the "scientist farmers". Additionally, T-teachers provided the tools for group discussions and the guidelines for facilitation processes in learning interactions. We also found the technical researchers and in collaboration with other projects/programs from Can Tho University and Can Tho city through the networks that were created by T-teachers for developing the sustainable livelihood models to respond to climate change" Mrs. Hanh said.

DISCUSSION

Transformative learning theory points to critical reflection and discourse as the two key processes by which individuals change their frames of references and behavior (Vulturius and Swartling, 2013). It enables people to make changes and to transform others and ourselves (Chaves et al., 2016). In the context of climate change, adaptation measures must contribute to increasing resilience and reducing vulnerability for the communities through reflecting learning, flexibility to experiment and to adopt novel solutions (Walker et al., 2002). Thus, learning process through instrumental and emancipatory learning at the heart of adaptive capacity allows for flexibility, refection, and ability to transform practices that can react more positively to change (Sharpe, 2016). Farmers in My Khanh commune started applying some adaptation measures to adapt to the change in climate and market conditions. However, these measures have been conducted based on their experiences, habit, and spontaneous responses. These farmers have been very active in learning and self-exploring to solve problems that have arised during their production process. Hence, this leads to several potentials for expanding learning and learning interactions within the communities in the context of climate change and market uncertainty.

Scientific research can reduce the risks associated with alternative production technology (Mochizuki, 2007). While researchers share their own experiences and knowledge with communities and add to the local knowledge base, they also have the power to create some of the results of social learning. The roles and responsibilities of teachers (including agricultural staffs or scientists) and scientific farmers, thus, particularly at the local level are very important to create emancipatory learning environments as well as to increase instrumental learning of farmers in the community. The process of the learning cycle is considered as four phases: experiencing, reflecting, conceptualization, and planning (Kolb, 1984). However, to gain the effective learning process, the participation and framing to change towards sustainability are critical (Wals and Heymann, 2004). The active participation requires a responsive design, implementation, and evaluation components (Phuong et al., 2018a). Findings from other studies show that the viability of participation depends greatly on the potential benefits that farmers can gain such as their expected increase in financial, human, and social capital (Cliffe et al., 2016; Togbé et al., 2015). Changes can result from both instrumental learnings as new skills and knowledge and emancipatory learning as gaining insight into one's own and others' interests, knowledge, and opinions (Vulturius and Swartling, 2013). Our results strongly suggest that learning and engagement in adaptation depend on how well scientific knowledge about climate impacts and adaptation measures fits the practical needs, objectives and aspirations of stakeholders. This is consistent with literature that finding experiences from extreme natural events can motivate people to take action to lower the risks from future climate change impacts (Le Dang et al., 2014a; Phuong et al., 2017a; Phuong et al., 2018a).

Institutions and governance processes can be catalysts for creating a generative social learning environment that

allows for implementing different types of instrumental and emancipatory learning (Phuong et al., 2017b; Phuong et al., 2018b; Sharpe, 2016). This is significant in combination both innovations from the local community and scientific knowledge from the university as well as policy planning from policy-makers or authorities that had great influence on farmers' learning and their process of adoption adaptation measures in the climate change context (Phuong et al., 2018b). This study suggests that engagement with climate change adaptation can result from emancipatory learning that changes the way an individual detects information in media and relates it to personal and scientific knowledge about climate change and climate change adaptation. Social networks via community learning are also important to provide the foundation for learning together and learning from each other (Phuong et al., 2017a). However, to take forward these kinds of learning, it needs to have an appropriate mechanism and principles for sharing and learning in the communities (Chaves, 2016). The needs of the communities include how to connect and collaborate with a diversity of actors for collective actions, particular coordination with mass organizations, community-based organizations, the attention of local and higher governments, and the support of the scientific agencies. It also needs to clarify roles, responsibilities, accountabilities, and benefits of various stakeholders in the processes of transformative learning development or social learning activities. Therefore, the conditions for efficient transformative learning include collaborative production, collective learning, and policy support, supporting and consulting of scientists, and stabilizing market issues.

Conclusion

This paper supports the existing argument(s) that transformative learning for sustainability is a key to enable adaptation and resilience to climate change, while recognizes the superficiality or depth of this learning impacts on its effectiveness at bringing about transformation of perceptions, knowledge, and actions. Learning was discussed in two dimensions: instrumental learning and emancipatory learning. A strong indication of transformative learning for sustainability in this study was observed and was related to the number of reasons to motivate the adaptation practices. The efficiency of the instrumental learning and emancipatory learning are considered an important driving adaptation and transformative learning for sustainability tended to be sources of information that allowed for observation and experimentation. Using visible indicators of environmental problems such as manifestations and impacts of climate change as well as field observation is important for a farmer's learning process as positive experience with one aspect of sustainable agriculture can result in motivation to try new aspects, resulting in a gradual learning process characterized by shifting perceptions and actions. Understanding how learning occurs is important for facilitating sustainability in agriculture. Therefore, fostering conditions that are conducive to learning and particular transformative learning, farmers would likely to open more and more to new ideas and practices that promoted sustainability and adaptation in climate change context, are important for developing the knowledge required to build adaptive capacity.

Acknowledgments

This work was funded by the ISSC project. We are grateful for the comments and suggestions by Prof. Arjen Wals on an earlier version of the paper and the feedback by Ms Hoa on the English corrections and her comments. We also would like to thank friends and lecturers at Can Tho University for their support during the survey. We also thank farmers in My Khanh commune for all their valuable data and support during the study.

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