CHAPTER 3

Methodology

This research developed additional social science ontologies from the organic rice farming knowledge as an appropriate technology to transfer knowledge to rural non-science and technology educated farmers of Phrao District, Chiang Mai Province, Thailand as a research case study. The vocational learning process was experimented with Bloom's Taxonomy framework to evaluate additional ontologies effectiveness and vocational life-long learning of case study.

This study proposes an effective tutorial scientific ontological based-knowledge with the objective of using a knowledge engineering approach to provide domain knowledge to support an appropriate technological knowledge for non-science and technology educated farmers in order to close gap between expert and organic farmers. This study focused on the organic rice farming particularly useful in rural areas and communities, as appropriate technology and using Phrao District, Chiang Mai Province, Thailand as a case study where most people had educated at basic education level. This research proposes additional ontologies of the organic rice as an appropriate technology by extracting key scientific concept from the biology, chemistry, physics and mathematics concepts as additional ontological knowledge. These four social scientific concepts relate to the basic education in lower secondary school of Thai curriculum and in parallel four formal social science and technology ontological categories were developed using CommonKADS by semantic annotation technique. The biology, chemistry, physics and mathematics scientific concepts as well as the corresponding ontological domains were explained in more detail in the methodology section of this paper. Before considering social scientific ontological development in this research, it is necessary to outline and describe further what is meant by the term appropriate technological knowledge, particularly as it applies to the sustainable development projects. Then, this study provides learning process measurement of the organic rice farming knowledge by semantic annotation technique on Bloom's Taxonomy vocabulary in order to assess the ontology effectiveness.

In the context of academic researches this model based reasoning was associated with experts who have social scientific knowledge, which can be applied in local issue problem solving. This research elicited and structured knowledge from academic researches and experts. Knowledge capture were through interviews and used CommonKADS to structure the social scientific knowledge on organic rice farming domain knowledge. A knowledge model was characterized by knowledge being extracted from experts through training course and activities in order to allow people to be think as experts to solve their community problems. Explicit knowledge from the appropriate technology and academic researches was not currently recorded by local experts or expert knowledge workers, so people who utilize explicit knowledge cannot make decisions as experts. Knowledge workers (Phrao local community) also require a social scientific knowledge episodic scenario as a tool to inform their decision making as experts when they disseminate appropriate technology knowledge and research knowledge to communities.

The findings highlight a lack of specification of conceptualization understanding in basic education level of rural community people in Thailand being unsuccessfully transferred appropriate technology knowledge, which was maintained in the sustainable development projects. The science and technology ontology in appropriate technological knowledge should be the keystone of sustainable development projects, which knowledge workers need to understand and solve real world problems. The result from analysis of this research was that this lack of understanding of specification of conceptualization in appropriate technological knowledge should be addressed via a knowledge management solution. The experimental research designs on adaptive organic rice-farming samples as a learning process study samples because this group represents a research problem. The adaptive organic rice farmers were selected by taking a test that was in science and technology in organic rice farming concepts and designed by a researcher.

The requirement to remember and understand expert's specification of conceptualization means a method was needed to transfer appropriate technological knowledge from multiple sustainable development projects via additional social science ontology knowledge as knowledge representation. Ultimately, appropriate technological knowledge can be shared and reused in order to solve rural community problems. Furthermore, rural communities can learn from collaborative and expert experience to create new solutions to problems. Accordingly, it was necessary to manage appropriate technological knowledge and an additional ontology was needed to extend this appropriate technological knowledge to other social landscapes across Thailand.

Consequently, these adaptive organic rice farmers were divided equally into two groups, i.e., control group and experimental group. Only experimental group was trained social science ontologies before organic rice farming train. The additional ontology model focuses on social science and technology ontologies based on Thai curriculum of lower secondary school in order to effectively represent knowledge of the organic rice farming. This study has been mainly concerned with capturing and representing knowledge found in the logic and structure of the organic rice farming knowledge through effective tutorial ontology. This research aims at capturing domain knowledge in a generic way and a commonly agreed understanding of domain, which can be shared, reused and operationalized across communities. The effective social science ontologies contain the conceptualization within the biology, chemistry, math and physic concepts and the relations between them. This study has developed ontology, enabled annotation using knowledge engineering with a perspective on provision of a knowledge scenario. In this study, ontologies provide a means for modeling of the relevant organic rice farming knowledge and this research studied on learning process measurement of the organic rice farming knowledge by semantic annotation technique on Bloom's taxonomy vocabulary to prove the effectiveness of tutorial ontology. The social science ontologies were used as knowledge representation to transfer knowledge to rural farmers of Phrao District, Chiang Mai Province, Thailand as a research case study.

3.1 Research Framework

This study aims an effective tutorial scientific ontological based-knowledge with the objective of using a knowledge engineering approach to disseminate domain knowledge to support an appropriate technology and academic research for non-science and technology educated farmers in order to close gap between experts and organic farmers. This research focuses on the organic rice farming particularly useful in rural areas and communities, as appropriate technology and using Phrao District, Chiang Mai Province, Thailand as a case study where most people had an education at basic education level. This research proposes additional ontologies of the organic rice as an appropriate technology by extracting key scientific concept from the biology, chemistry, physics and mathematics concepts as additional ontological knowledge. These four social scientific concepts relate to the basic education in lower secondary school of Thai curriculum and in parallel four formal science and technology ontological categories were developed using semantic annotation as a tool for knowledge engineering approach. The biology, chemistry, physics and mathematics scientific concepts as well as the corresponding ontological domains were explained in more detail in the methodology section of this research. Before considering scientific ontological development in this study, it was necessary to outline and describe further what was meant by the term appropriate technology knowledge, particularly as it applies to the sustainable development projects. Then, this study provides learning process measurement of the organic rice farming knowledge by semantic annotation technique on Bloom's Taxonomy vocabulary in order to assess the ontology effectiveness. (Shown in **Figure 3.1**)

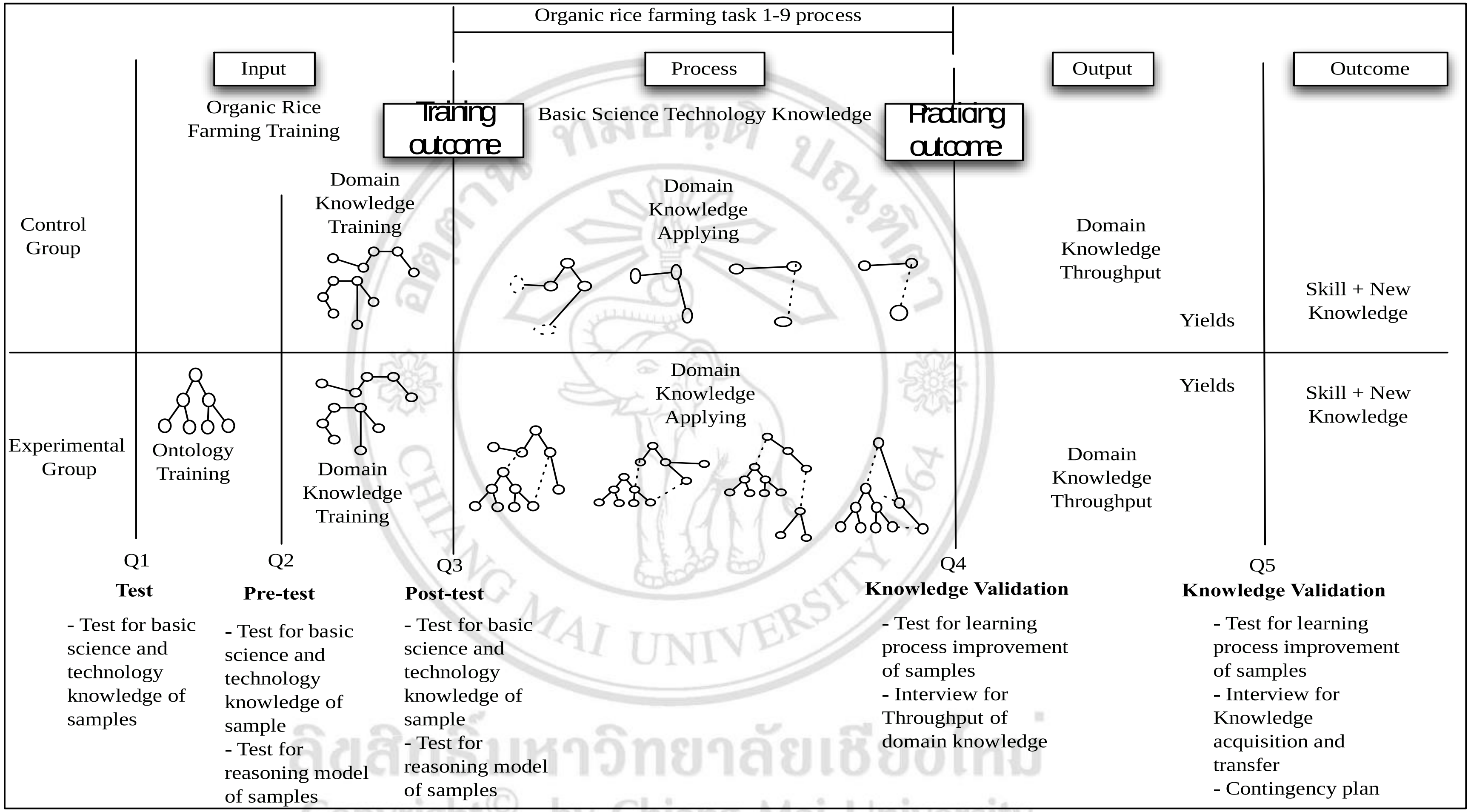

Figure 3.1 Conceptualizes the proposed methodology used in this research. These stages, along with methodological detail were described in **Table 3.1** and the following sub-sections

3.2 Methodological Design

The tutorial social science ontology effectiveness for non-science and technology educated farmers on appropriate technology knowledge transfer from sustainable development projects was proved regarding to conceptual framework. The methodological deign is shown in **Table 3.1**. This research focused on effective social science ontology for non-science and technology educated adaptive organic rice farmers and learning process measurement by semantic annotation on Bloom's Taxonomy vocabulary in Phrao District, Chiang Mai Province, Thailand.

The 5 steps of the methodological design for learning process improvement of non-science and technology educated adaptive organic rice farmers by tutorial science ontology were proposed which is shown in **Table 3.1**. The table provides concepts, theories, methodology, tools and techniques applied in this research to answer the study hypothesis.

Table 3.1 Concept of design the tutorial social science ontology effectiveness for non-science and technology educated famers on appropriate technology knowledge transfer

Step	Concepts/ Theories	Methodology	Tools and Techniques	Expected Output
1. Sample validation and selection	• Biodata of sample analysis • Pre-test	• Identify a suitable case study to prove additional ontology effectiveness as solution for scientific knowledge transfer	• Literature review • Semi-structure interview • Unstructured interviews • Organic rice farming test based on science and technology knowledge	• A suitable case study to prove additional ontology effectiveness as solution for scientific knowledge transfer

Table 3.1 Concept of design the tutorial social science ontology effectiveness for non-science and technology educated famers on appropriate technology knowledge transfer (Continued)

Step	Concepts/ Theories	Methodology	Tools and Techniques	Expected Output
		• Understanding the knowledge requirements from the case study		• Control and experimental groups of adaptive organic rice farming samples
2. Trainer expertise qualification and knowledge capture and knowledge analysis	Knowledge engineering (elicitation, analysis, representation, validation)	• To determine and analyze experts who possess scientific and technology knowledge within the appropriate technology knowledge and academic research for case study • To elicit, capture, analyze, synthesize and structure scientific and technology knowledge	• Social network analysis • In depth interview • CommonKADS	• Appropriate technology and academic research domain knowledge from experts to ontology development and for non-social science and technology educated famers

Table 3.1 Concept of design the tutorial social science ontology effectiveness for non-science and technology educated famers on appropriate technology knowledge transfer (Continued)

Step	Concepts/ Theories	Methodology	Tools and Techniques	Expected Output
		• To validate knowledge with the experts identified and qualified in step 2.		
3. Ontology identification and development	• Semantic annotation • Biology, chemistry, physics, and mathematics ontology based on Thai curriculum of lower secondary school	• Identify experts' jargon (domain concepts) • Develop social science and technology by semantic annotation with experts' jargon	• Ontologies as knowledge representation • CommonKADS	• Social science ontologies for tutoring non-science and technology educated adaptive organic rice farmer samples
4. Learning process implementation	• Appropriate technology and academic	• Design and create domain knowledge	• Adaptive organic rice farming sample in control	• Additional ontology effectiveness

Table 3.1 Concept of design the tutorial social science ontology effectiveness for non-science and technology educated famers on appropriate technology knowledge transfer (Continued)

Step	Concepts/ Theories	Methodology	Tools and Techniques	Expected Output
• Design learning activity based on building learning organization • Tutorial social science and technology ontology knowledge • Training organic rice farming course • Learning process verification	research knowledge training course • Creating, acquiring, and transferring knowledge	training course for knowledge workers based on the learning activity on building learning organization	and experimental group • Building learning organization: experimenting with new approaches to work, knowledge transfer through organizations • Expert verification	
5. Knowledge validation and learning process improvement measurement by semantic annotation on Bloom's Taxonomy	• Pre-test and post-test design by experts based on Bloom's Taxonomy vocabulary	• Prove the effective of social science ontology approach for delivering scientific and technology	• Pre-test and post-test • Interview • Contingency Plan • Semantic annotation	• Non-science and technology educated farmers can improve learning process behavior

Table 3.1 Concept of design the tutorial social science ontology effectiveness for non-science and technology educated famers on appropriate technology knowledge transfer (Continued)

Step	Concepts/ Theories	Methodology	Tools and Techniques	Expected Output
	• Semantic annotation on Bloom's Taxonomy vocabulary measurement			

Table 3.1 provided the research agenda that consisting of steps, concepts, theories, methodology, tools, techniques and expected output of tutorial social science ontology model for non-science and technology educated farmers.

This study developed additional social science ontologies from the organic rice farming knowledge as an appropriate technology to transfer knowledge to rural non-science and technology educated farmers of Phrao District, Chiang Mai Province, Thailand as a research case study. The vocational learning process was experimented with semantic annotation on Bloom's taxonomy vocabulary framework to evaluate additional ontologies effectiveness and vocational life-long learning of case study. This research studied on learning process measurement of the organic rice farming knowledge by semantic annotation technique on Bloom's Taxonomy vocabulary to prove the effectiveness of tutorial ontology. The social science ontologies were used as knowledge representation to transfer knowledge to rural farmers of Phrao District, Chiang Mai Province, Thailand as a research case study as shown in **Figure 3.2.**

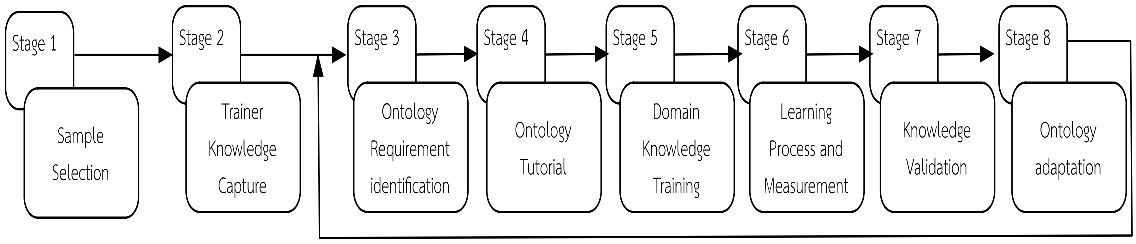

Figure 3.2 The methodological design

This reserch provides a learning process technique of an effective tutorial ontology modeling on organic rice farming for non-science and technology educated farmers using knowledge engineering. This research learning process shows how to transfer appropriate technology effectively for non-science and technology educated farmers via tutorial social science ontologies.

3.2.1 Sample selection: Stage 1

This stage involves selecting, and then reviewing existing knowledge from academic researches and appropriate technology knowledge from sustainable development projects. A suitable case study was identified to develop a solution for scientific knowledge. Phrao district in Chiang Mai province was selected as an appropriate case study. Phrao District exists partnership and representative of developing area of Chiang Mai University and use the knowledge from the sustainable development projects to develop the community. The knowledge requirement to renew the case study community was validated by non-structured interviews with stakeholders from the case study. There were 12,120 families these were 36,393 populations including men18,160 and women 18,233 people. Most of people in Phrao had the highest education level at primary school (Pratom 4-6) where was included 9,727 men and 9,716 women people. Most people in this area were labor employees who have not certain incomes and others were farmers. Consequently, the rural people in Phrao district can be research problem representation because most rural people graduated at primary school and lack of science and technology knowledge.

The stage 1 involved the deciding upon, and then reviewing existing knowledge from a sustainable development project and an organic rice farming knowledge as an appropriate technology. An organic rice farming as an appropriate technology from a suitable sustainable development project was identified to develop additional ontologies solution for appropriate technology. It was envisaged that Phrao District, Chiang Mai Province, Thailand was selected as a case study to transfer organic rice farming knowledge. The requirement knowledge to renew case study community was validated by non-structure interview and vocational organic rice farming knowledge test from stakeholders and bio data analysis of case study. This research focused on adaptive organic rice farmer to be a study sample to prove learning skill from additional ontologies, which was developed and cognitive level of samples on learning process. The samples of the case study were divided into a control group and experimental group in order to test the effectiveness of additional social science ontology of appropriate technology and cognitive level on learning process.

This research focused on adaptive organic rice farmers to be a study sample to prove learning skill in learning process from additional ontologies, which was developed. The samples of case study were divided into two groups, which were control group and an experimental group in order to measure the learning process by semantic annotation technique on Bloom's Taxonomy. Additionally, this stage involved the reviewing and deciding upon existing knowledge from a sustainable development project which was an organic rice farming knowledge as an appropriate technology.

The method of data collection consisted of:

1. The leader of organic rice farming community selected the farmers in this community to be samples of this research. The farmer samples were doing organic rice farm less than 2 years as the adaptive organic rice farmers.
2. The test of science understanding in organic rice agriculture was designed, verified and validated by three experts.

3. The organic rice farmers should take the test of science understanding in organic rice farming. Then, these tests were scored by experts and researcher.

There were only 37 pure organic rice farmers in Phrao District community that including adaptive organic rice farmer step 12 farmers in this organic rice farming community. To qualify sample selection in this research using a test that was designed the questions in science and technology ontology knowledge as following (as shown in **appendix B**):

1. What decomposes fossil that is found in soil?
2. What decomposes it into humus form?
3. What are appropriate compositions in soil in agriculture and useful for growing?
4. What are the objectives of cover crop?
5. How to eliminate pest and insects during crop by biological methods?
6. What is microorganism in soil and how microorganism is useful in agriculture?

All 37 organic rice farmers answer 6 questions which these farmers had to response these questions together at the same time in front of the researcher. This research focused on the answer from 12 adaptive organic rice farmers who could be the research problem representative samples. The qualification of adaptive organic rice farmers must be non-science and technology education or lack of science and technology basic education. The research adaptive organic rice farming samples who could not answer the science ontology questions were selected for research examination samples. Then, the adaptive organic rice famer samples were divided equally into control and experimental groups.

3.2.2 Trainer Knowledge Capture Using CommonKADS: Stage 2

In this stage, the experts were chosen from organic rice farming research experience and work with rural community and the experts should be in academic researchers, practitioners and local experts' criteria. The chosen experts who have scientific appropriate technology knowledge from sustainable development projects and use it for local issue problem solving related to scientific knowledge. The expert analysis was appropriate as a strategic tool for expert localization, identification of knowledge communities and analysis of the structure of intra- and inter-organizational knowledge flows. Interviews were used to question researchers and local experts in order to identify experts with appropriate technology scientific knowledge.

This stage involves interviewing experts, and reviewing, eliciting and collecting existing scientific knowledge from the sustainable development projects and academic researches to capture appropriate technology knowledge from them. All researches, repositories and manuals from experts currently available on the sustainable development project websites, National Research Council Thailand: NRCT, Universities in Thailand and workplace were also collected and reviewed prior to capture. Repositories were likely to include manuals, scientific documents, patents and publications. Appropriate technology scientific knowledge from experts were elicited, analyzed and structure through intensive-tasks, inferences and domain knowledge using CommonKADS to formalize appropriate scientific knowledge for the case study. This research used CommonKADS, which provides tools such as a modeling suite and templates for different knowledge intensive tasks of appropriate technology knowledge. Then social science ontologies were developed in terms of biology, physics, chemistry and mathematic concepts, which based on Thai curriculum basic education of lower secondary school.

The method of data collection consisted of:

1. The academic researcher and assistant chancellor of research and research management of Chiang Mai University recommends the expert who expertise's in organic rice farming in rural community.
2. The record was transcribed from voice and video recorder in order to draw knowledge map.
3. The repositories of organic rice farming was combined and used as knowledge support.

4. The knowledge analysis and synthesis were used CommonKADS as a tool of knowledge engineering. The knowledge map was represented in form of task, inference and domain knowledge. Then the knowledge map was arranged, revised, and verified by the experts of this research again.
5. The organic rice farming knowledge in rural area community base is represented in knowledge map.

The guideline questions for interviewing experts of organic rice farming as an appropriate technology as following:

1. What is organic rice farming?
2. How many tasks in organic rice farming process?
3. How to do organic rice farming of each task?
4. Why are you doing this in each task?
5. What are your additional techniques in organic rice farming?
6. How to manage the crop when meet the disaster or problem?
7. When does task start and finish and how long do you do all tasks?
8. Who are the helpers about organic rice farming in rural area?
9. Where can retrieve knowledge of organic rice farming?

The study focuses on a social scientific ontology (biology, physics, chemistry and mathematic concepts) to enable tutor and reuse of organic farming was based on an appropriate technology. The additional ontology model focused on social science and technology ontologies were based on Thai curriculum of lower secondary school in order to effectively represent knowledge of the organic rice farming that ontology defines specification of conceptualization. Organic rice knowledge as an appropriate technology was subsequently validated, tested and disseminated via science ontology for farmers in Phrao District, Chiang Mai Province as knowledge workers, particularly in rural areas of Thailand and with a particular methodological emphasis on the use of CommonKADS.

Knowledge analysis

Knowledge analysis means understanding domain knowledge in a context, which was situated in community contexts. The contextual knowledge analysis was performed to explore different community situations where domain knowledge was created, disseminated and utilized. The approach to contextual knowledge analysis was a differentiation between creation, dissemination and utilization of knowledge. The CommonKADS modeled the organic rice planting domain knowledge in this study into three corresponding parts, task knowledge, inference knowledge and domain knowledge as shown in **Figure 3.3**. The three main parts were linked to task knowledge which describes the knowledge-intensive tasks of the organic rice growing, inference knowledge which describes using knowledge to carry out the reasoning process and domain knowledge which refers to knowledge of human experts based on their experiences. The domain knowledge was validated and taught back from experts.

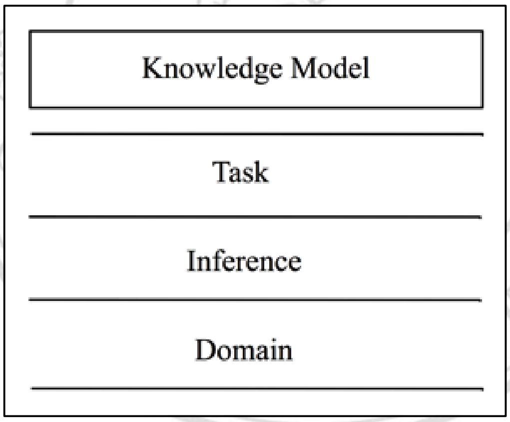

Figure 3.3 Knowledge Model of CommonKADS Template

3.2.3 Ontology Identification and Development: Stage 3

This step of the methodology developed additional science ontologies and knowledge model using CommonKADS. The CommonKADS model had a variety of components such as the organization model, task model, agent model, knowledge model, communication model and design model. This study emphasizes on knowledge model in order to elicit domain knowledge of appropriate technology and academic research in organic rice farming field from exerts. When knowledge was captured to task, inference and domain knowledge, the experts' domain concept knowledge were identified. This research identified experts' jargons in domain knowledge, which were experts' vocabulary in their domain knowledge. The ontology knowledge creation was based on four main science ontologies which were derived from the biology, chemistry, physics and mathematics concepts of Thai curriculum in lower secondary school which all were reference by National Science and Technology Development Agency of Thailand. Consequently, only the experimental group was tutored the science ontologies on organic rice farming before both control and experimental groups were trained domain knowledge by experts. (Shown in **Figure 3.4**)

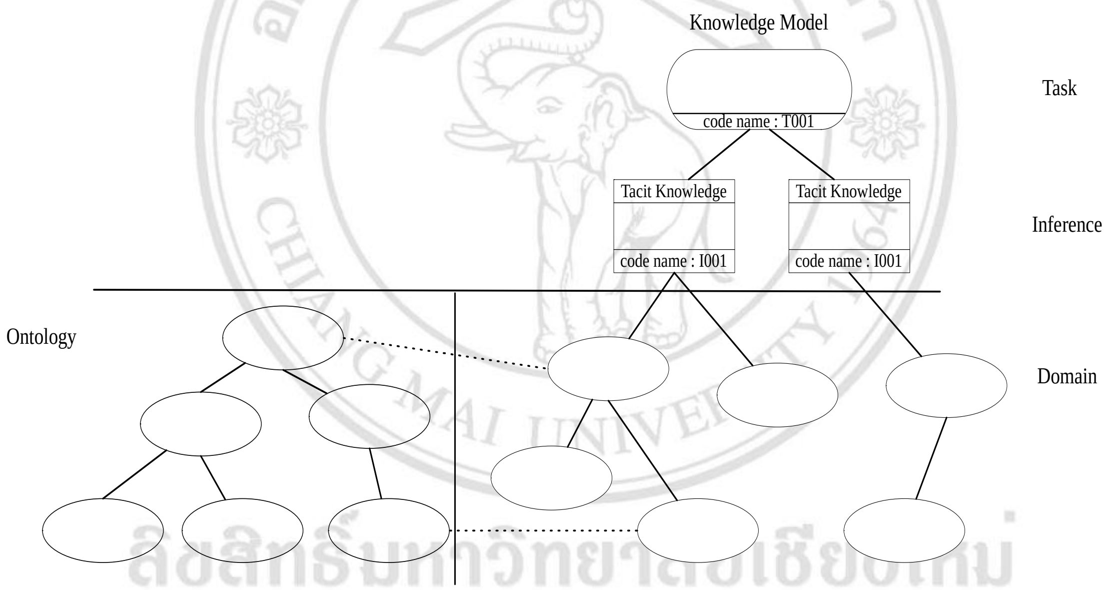

Figure 3.4 Knowledge mapping template

3.2.4 Ontology Tutorial: Stage 4

This stage provides additional social science ontologies, which were developed in stage 3 for tutoring adaptive organic rice famer sample in order to prove the hypothesis of ontology effectiveness improving learning process.

Thus, only the experimental group was tutored social science ontologies of the organic rice farming ontology knowledge based on four main social science ontologies derived from the biology, chemistry, physics and mathematics concepts of Thai curriculum in lower secondary school by a researcher who had science background. The tutorial ontology process for sample in experimental group took place before the organic rice farming training course from experts train both control and experimental groups.

The science ontology knowledge version I based on biology, chemistry, physics and mathematics concepts were train and explain to experimental group by researcher who has a Master degree of science. All social science ontologies version I were in **appendix D**, so a second social science ontology could be adapted in version II when the implementation learning process finished.

3.2.5 Domain Knowledge Training: Stage 5

The adaptive organic rice farmer samples in both control and experimental groups were trained the domain knowledge of intensive organic rice farming tasks by experts who were academic researcher in Chiang Mai University and practitioner in field of appropriate technology knowledge of organic rice farming. The training course and activities were designed to cover all tasks of organic rice farming crop knowledge, which was expected that the learners understand and apply knowledge of appropriate technology for their organic rice farms.

The term of expert's domain knowledge refers to knowledge which was specific for a given domain of practice, both in terms of more abstract knowledge and domain knowledge were embedded in the organizational, social and material context of a given practice. The organic rice farming was including of nine tasks of organic rice planting knowledge: T1-soil analysis, T2-seed selection, T3-rice seedling, T4-soil preparation, T5-organic rice growing, T6-water management, T7-rice disease, pest, insect protection, T8-harvest and T9- soil development. Each of 9 tasks was modeled into task, inference, domain knowledge from organic rice farming trainer. Trainers of this research design the training course, which it is shown in **appendix A**.

3.2.6 Learning Process and Learning Process Measurement: Stage 6

This step provides measurement of tutorial science ontology effectiveness on organic rice farming knowledge in learning process of both control and experimental groups as shown in **Figure 3.4**. The average throughput of organic rice farming domain knowledge in learning process were counted and validated in terms of applying domain knowledge, effectiveness domain knowledge with their community and acquiring knowledge by themselves in both control and experimental sample groups. Additionally, learning process of non-science and technology educated samples were measured by semantic annotation technique on Bloom's Taxonomy vocabulary.

The method of data collection consisted of:

1. The course agenda and learning activities were designed by experts and researcher following experts' training experience and building organizational learning framework.
2. The tests in Q1-Q5 were designed, verified and validated by experts before using these tests for both sample groups.
3. In-depth interview was conducted among experts by using the test agendas and the semi-structured open-ended questions in order to complete the answers from both sample groups (shown in **Table 3.2**).
4. The knowledge from the answer of both sample groups was validated using CommonKADS and semantic annotation between experts' jargon (domain knowledge) and ontology.
5. All answers from both sample groups (Q1-Q5) were analyzed and synthesized using manual semantic annotation techniques.
6. The researcher created the scored form to evaluate the cognitive level (shown in **Table 3.3**). The leaning process measurement was used semantic annotation technique on Bloom's Taxonomy vocabulary.

7. The learning activities were based on biological substances were designed by experts. The both sample groups' participations, questions and output were observed.
8. The voice records and the video record were transcribed and semantic annotated domain knowledge and ontology. Then, experts verified the knowledge map from sample knowledge validation.
9. Experts and researcher corrected the answers from both sample groups.

The control and experimental groups were divided equivalently into a group and each group has a mentor who has an organic rice farming experience. When an experiment started as shown in **Figure 3.4**, both sample groups were tested with test in field of organic rice agriculture that is designed by trainers (step: Q1) and then only experimental group were tutored science ontologies of organic rice farming based on the biology, chemistry, physics and mathematics concepts of Thai curriculum in lower secondary school. A step Q2, both sample groups were tested with pre-tested that was designed by trainers and sample groups were interviewed as well.

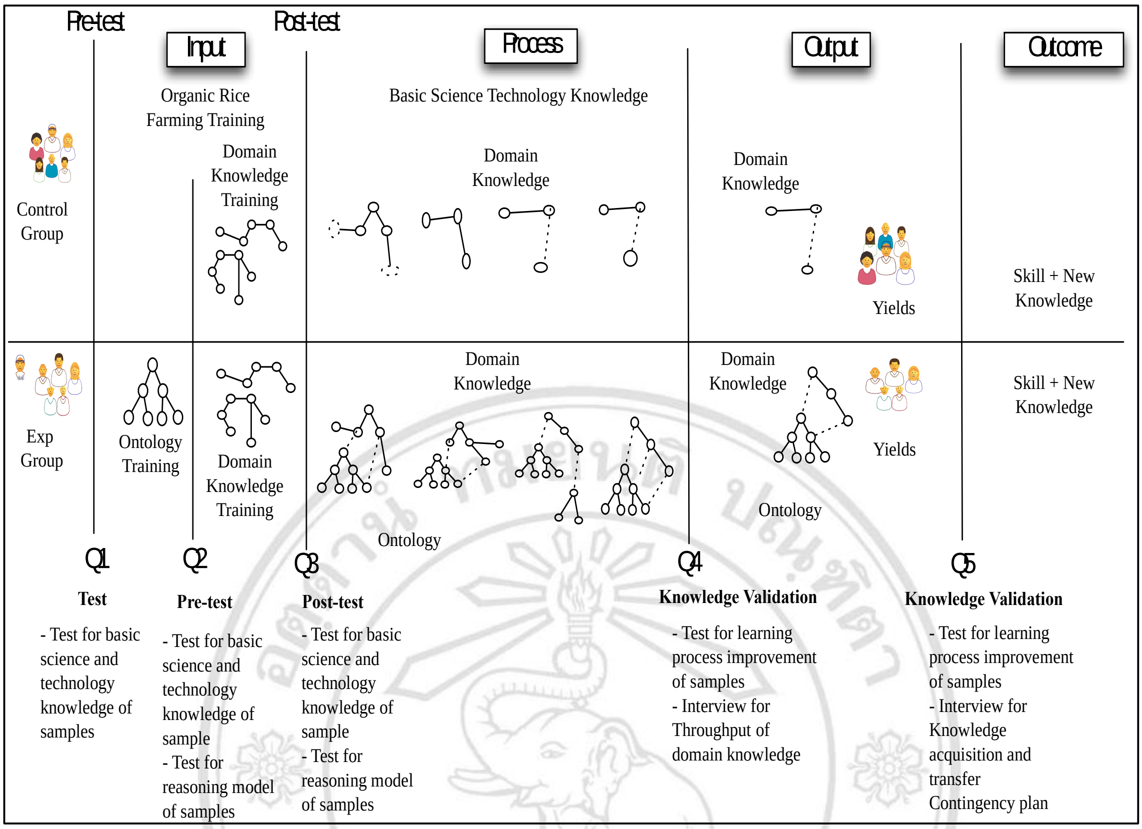

Figure 3.5 The learning process of both sample groups

The control and experimental groups were trained in organic rice farming by trainers who expertise in organic agriculture and organic rice agriculture which were appropriate technology then both adaptive organic rice famer samples were tested with post-test after training course finished (step: Q3). Both adaptive organic rice farming sample groups planted organic rice and applied appropriate technology knowledge that was trained in organic rice farming process in their own croplands. Consequently, learning process of samples were assessed as step Q4 the training outcome of the learning process that was assessed via capturing organic rice domain knowledge from both sample groups using CommonKADS by manual semantic annotation technique (shown in **Figure 3.5**). The learning process was designed to measure the ontology effectiveness and the sample learning method that following only the experts or adopting the domain knowledge by using ontology in reasoning. The control and experimental groups were trained on organic rice farming by experts and were tested for knowledge gained from trainers following Bloom’s Taxonomy framework. There was 148-domain knowledge of nine intensive tasks of organic rice farming which were disseminated to both sample groups. The experimental group only was trained **m** number of social science ontologies on organic rice farming of first version.

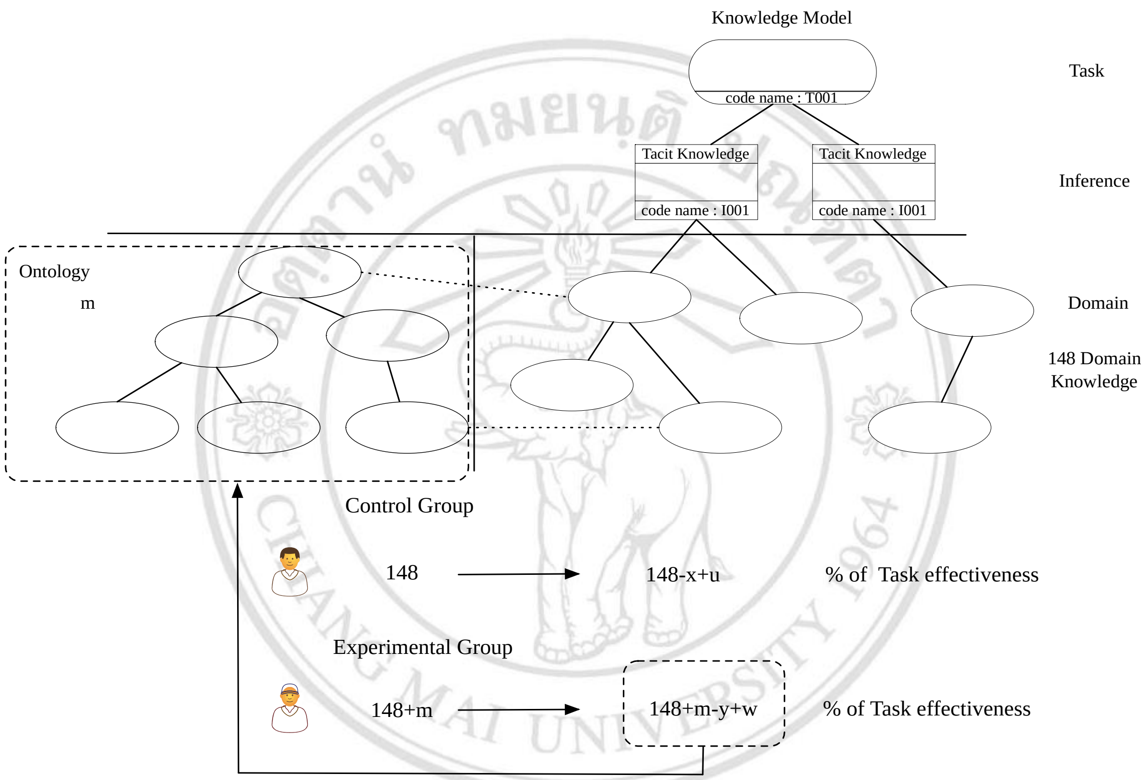

Figure 3.6 A learning process on organic rice farming knowledge from both control and experimental groups. (148 number of domain knowledge, m=number of ontology, x;y =lost domain knowledge, u;w=new domain knowledge of adaptive organic rice farmers).

An ontology mapping was a set of expressions that has a different ontology of both sample groups, which were mapped in learning process. The organic rice farming domain knowledge of both adaptive farmer sample groups were elicited and captured via interview using CommonKADS to map learning outcome defining with jargon of experts using semantic annotation to get throughput of effectiveness domain knowledge and comparing between one by one of each control group and experimental group.

The measurement of learning process of samples by semantic annotation on Bloom's Taxonomy vocabulary at step Q5 (shown in **Figure 3.6**) that it was begun with reading learners' answers from start to end and observing learner's action. The answers and observation of both sample groups were captured and modeled using CommonKADS by manual semantic annotation techniques then these knowledge models were manually annotated all annotations in order as they were found to give the most accurate results by semantic annotation measurement on Bloom's Taxonomy vocabulary. All questions in step Q1-Q5 used Bloom's Taxonomy vocabulary to design examination and interview question agenda by trainers and a researcher as shown in **Table 3.2**.

Table 3.2 Questions guideline and expected learners' answer and learners' behavior and based on Bloom's Taxonomy vocabulary of learning process measurement for non-science and technology educated adaptive organic rice farmers in both control and experimental groups.

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
Bloom's Taxonomy Vocabulary	Knowledge: arrange, define, duplicate, label, list, memorize, name, order, recognize, reproduce state	Comprehension: classify, describe, discuss, explain, express, identify, indicate, locate, recognize, report, restate, review, select, translate	Application: apply, choose, demonstrate dramatize, employ, illustrate, interpret, operate, practice, schedule, sketch, solve, use, write	Analysis: analyze, appraise, calculate, categorize, compare, contrast, criticize, differentiate, discriminate, distinguish, examine, experiment, question, test	Evaluation: appraise, argue, assess, attach, choose compare, defend estimate, judge, predict rate, core, select, support, value, evaluate	Synthesis: arrange, assemble, collect, compose, construct, create, design, develop, formulate, manage, organize, plan, prepare, propose, set up, write
T1: Soil analysis	*List* the soil composition vocabulary both biological and physical properties	*Explain* about soil analysis methods	*Apply* experts knowledge how to do soil sampling	*Analyze, criticize, examine* soil by themselves *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to soil property	*Create* and *Propose* their own knowledge for organic rice farming in next crop

Table 3.2 Questions guideline and expected learners' answer and learners' behavior and based on Bloom's Taxonomy vocabulary of learning process measurement for non-science and technology educated adaptive organic rice farmers in both control and experimental groups. (Continued)

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
T2: Seed selection	*Define* seed selection methods and seed conservation	*Describe* how to keep rice seed before growing using correcting method	*Practice* seed selection by following expert's domain knowledge	*Discriminate* good seed or bad seed for crop *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to seed quality	*Create* and *Propose* their own knowledge for organic rice farming in next crop
T3: The rice seedling	*Arrange* the rice seedling process in organic rice farming procedure	*Identify* the rice seedling useful for organic rice farming	*Apply and Practice* the rice seedling domain knowledge from experts	*Compare* the methods of rice seedling with another rice seedling methods *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to rice seedling methods	*Create* and *Propose* their own knowledge for organic rice farming in next crop

Table 3.2 Questions guideline and expected learners' answer and learners' behavior and based on Bloom's Taxonomy vocabulary of learning process measurement for non-science and technology educated adaptive organic rice farmers in both control and experimental groups. (Continued)

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
T4: Soil preparation	*List* the soil preparation process in detail	*Explain* how to prepare soil for planting	*Apply* soil preparation knowledge from trainers	*Analyze* soil preparation methods *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to soil preparation quality	*Create* and *Propose* their own knowledge for organic rice farming in next crop
T5: Planting organic rice	*List* the organic rice planting procedure in detail	*Discuss* and *Explain* how to grow organic rice in their farm land	*Operate* planting organic rice with experts' knowledge	*Analyze* planting organic rice from their own method with experts' method *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to organic rice farming process	*Create* and *Propose* their own knowledge for organic rice farming in next crop

Table 3.2 Questions guideline and expected learners' answer and learners' behavior and based on Bloom's Taxonomy vocabulary of learning process measurement for non-science and technology educated adaptive organic rice farmers in both control and experimental groups. (Continued)

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
T6: Water management	*Define* the water management process for organic rice farming	*Classify* the difference aspects of water management between 1 time crop a year and 2 times crop a year	*Apply* water management knowledge from experts	*Calculate* volume of water and *analyze* water management methods *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to water management process	*Create* and *Propose* their own knowledge for organic rice farming in next crop
T7: Diseases and pest control	*Define* organic rice diseases and pest, *Define* protection and take care product during crop till harvesting	*Explain* the method how to protect product form disease and pest and take care organic rice entire crop	*Apply* disease and pest control knowledge from experts	*Analyze and criticize* of disease and pest control for crop *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to disease and pest control quality	*Create* and *Propose* their own knowledge for organic rice farming in next crop

Table 3.2 Questions guideline and expected learners' answer and learners' behavior and based on Bloom's Taxonomy vocabulary of learning process measurement for non-science and technology educated adaptive organic rice farmers in both control and experimental groups. (Continued)

	Remembering	Understanding	Applying	Analyzing	Evaluating	Creating
T8: Harvesting	*Memorize and Recognize* of organic rice products, *Note and name* products	*Describe* how to harvest crop correctly	*Apply* harvesting method from experts' technique and knowledge	*Analyze and criticize* harvesting methods *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to harvesting quality	*Create* and *Propose* their own knowledge for organic rice farming in next crop
T9: Soil Development	*Define* appropriate soil properties both biological and physical properties for crop	*Explain* how to do soil development for next crop	*Apply* soil development knowledge and technique form experts	*Analyze* soil development methods and procedures *Write and Explain* contingency plan for organic rice farming	*Evaluate* their own products relate to soil development quality	*Create* and *Propose* their own knowledge for organic rice farming in next crop

The guide line questions in tests of pretest in overview, test Q1-Q5 is as following:

The pre-tests of oranic rice farming: The questions of understanding of organic rice production. Mark ☑ when the answer is correct and marked ☒ when the answer is incorrect.

1. What is organic rice?

☐ Organic rice produced by the organic production method. The production of organic rice allowed to use chemical or synthetic additives such as chemical fertilizer that produces good quality and safe rice. As a result, consumers are hygiene and a better quality of life.

2. Organic rice is different from the typical rice?

☐ Difference: Organic rice production is a production system that focuses on the story of agriculture. Nature is important, namely the preservation of natural resources, natural fertility restoration. To maintain the balance of nature, and to take advantage of the natural world to sustainable manufacturing is improving soil fertility by plant family plants such as beans, turnover.

3. How to select varieties of rice to produce organic rice for cultivation?

☐ Rice planting should have used the growth properties suitable for the environment in the area and to produce well in soil that is rich and insect and disease resistance. Grain and seed quality foes meet the needs of consumers, organic rice, organic rice production at present mainly jasmine rice 105 species the grain quality rice.

4. How to grow organic rice?

☐ The organic rice planting is most suitable for organic rice production, because the soil preparation, valleys, controls the water level should reduce weed growth and planting rice seedling into the ground that helps rice can compete with weeds in 10 days. Choosing rice strong and without the disease and insect damage.

5. Water management for organic rice production?

☐ Water levels are correlated with the growth of stems and yield of rice. Directly in rice tillers if the water level is very high, making the crop to escape the water, making it weak and falling. During this period, the water level should be maintained at around two centimeters but if the crop water stress will grow weeds compete with the crops. So the proper water level throughout the growing season. The water level should be maintained at doses up to 2-3 cm before harvest about 3-5 days. The area was dry enough to harvest.

Q1, Q2 and Q3 tests: pre-training and post-training in learning process. The questions in these tests were designed into nine tasks of organic rice farming. All questions were used Bloom's Taxonomy vocabulary. The question examples were as following:

T1 soil analysis and selection of planting area

1. Explain the organic matter, the essential elements are composed of? How to determine?
2. What is a microorganism in the soil? What it should be? How to check?
3. Are Inorganic and organic matters necessary? What is the concentration of minerals and how much to be suitable for organic rice cultivation? How to increase the organic minerals in the soil?
4. What is acid-base value? What is the element that is associated with the acid-base of the soil and should be reflecting to the growth of the rice? How to check by yourself?
5. What is the quantity of air contaminants in the soil is composed of that is relating to the integrity of the soil? What are contaminants quantity detection methods?

Q4 and Q5 test for knowledge validation: the guideline questions are following:

1. What is the knowledge that the samples applying to their organic rice farming work?
   - 1.1 How to apply domain knowledge to your farm?
   - 1.2 Why you have to do that?
   - 1.3 When you have to do?
   - 1.4 Who you asked for your help?

2. What is the knowledge that effectiveness for your organic rice farm?
   - 2.1 How to apply domain knowledge to your farm?
   - 2.2 Why you have to do that?
   - 2.3 When you have to do?
   - 2.4 Who you asked for your help?

3. What is the knowledge that you acquiring and where is you retrieving?
   - 3.1 How to apply domain knowledge to your farm?
   - 3.2 Why you have to do that?
   - 3.3 When you have to do?
   - 3.4 Who you asked for your help?

4. Writing your explanations on contingency plan for organic rice farming management? : to test the training outcome, stimulate outcome and closed gap between experts and knowledge workers. There were six disasters for organic rice farming that were verified by experts. There are including chemical exploration, storm, flood, cold weather, drought, disease; pest and weeds.
   - 4.1 How and Why?
   - 4.2 How and How?
   - 4.3 Why and How?
   - 4.4 Why and Why?

This research uses manual semantic annotation technique on Bloom's Taxonomy vocabulary to measure learning process improvement of non-science and technology educated organic rice farmers. (Shown in **Figure 3.6**)

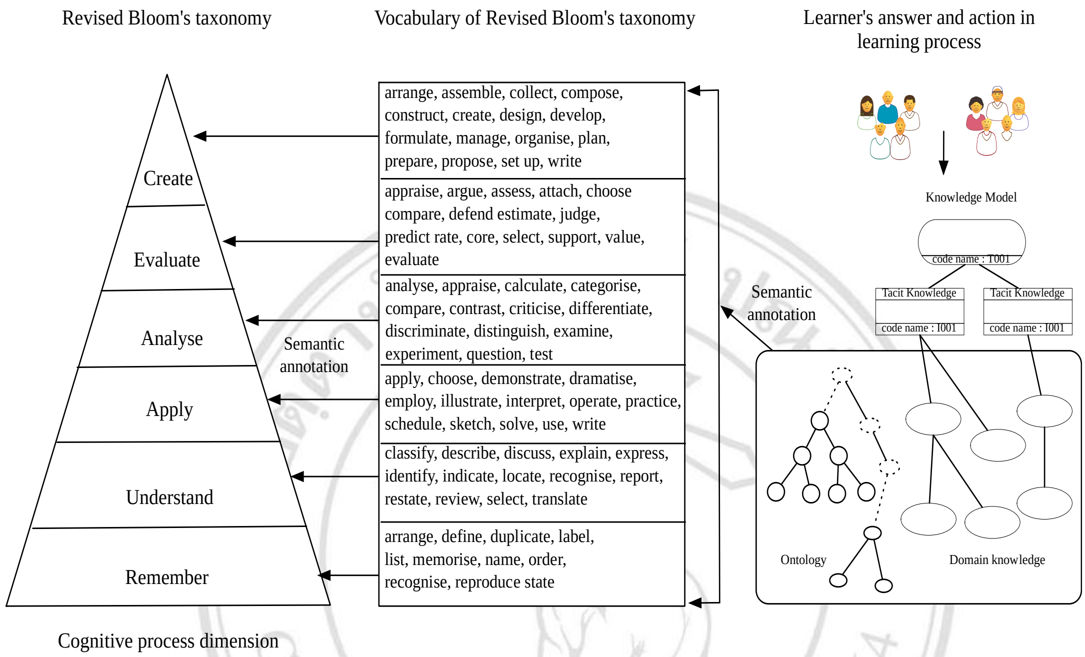

Figure 3.7 A semantic annotation technique on Bloom's Taxonomy vocabulary

The experts and researcher of this research correct the answers and skill observation in Q1-Q5 of both sample groups then the corrected answers should be analyzed and synthesized using CommonKADS into task, inference and domain knowledge. The measurement of learning process improvement by innovative semantic annotation on Bloom's Taxonomy vocabulary was used to assess cognitive level of both non-science and technology educated farmer sample groups. The evaluation form in **Table 3.3** was used to measure the cognitive level of samples on organic rice farming knowledge.

Table 3.3 Cognitive behavior evaluation form for non-science and technology educated farmers in both control and experimental groups

Cognitive behavior indicator	Fail (0 points)	Fair (1 points)	Pass (2 points)	Good (3 points)
Remember	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers
Understand	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers
Apply	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers
Analyze	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers
Evaluate	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers
Create	Could not answer all questions	Answers are not clear and get to the key words of correct answers, Confusing answers	Answers get to the points of questions but it is still needed more detail	Answers are complete and covered for all aspect of questions, Clear answers

3.2.7 Knowledge Validation and Ontology Adaptation from Samples: Stage 8

The tutorial social science ontologies on organic rice farming are validated via a count of number of using domain knowledge to organic rice farming effectively from both control and experimental groups by interview (shown in **Figure 3.7** and **Figure 3.8**). Some ontology probably cannot be used on organic rice appropriately, and some ontology of their samples can be created and reasoned which was related to expert's domain knowledge to apply for organic rice farming. In this step, the new domain knowledge on organic rice farming which was appropriate to a case study community were created from non-science and technology educated farmers in both sample groups.

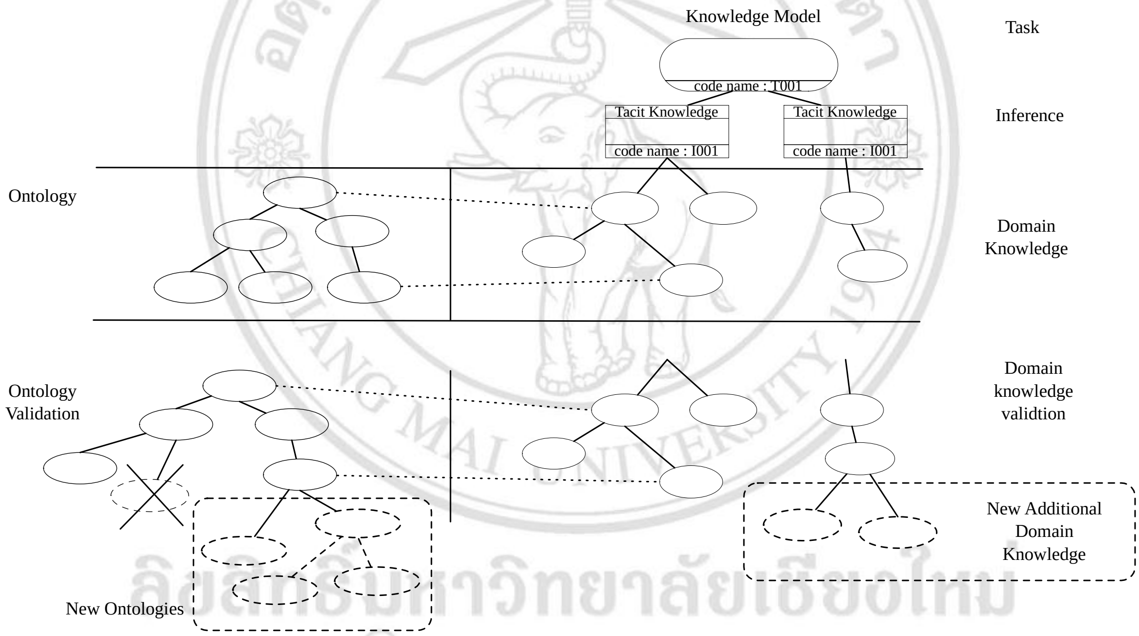

Figure 3.8 Ontology adaptation and Knowledge validation technique

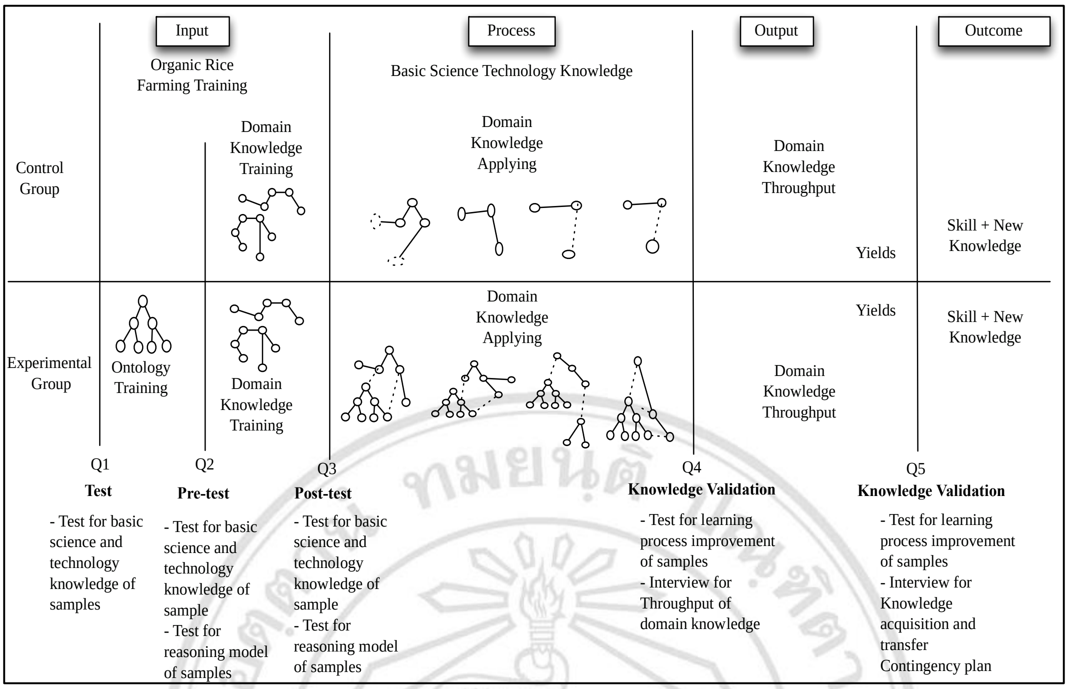

Figure 3.9 Knowledge validation procedures from both control and experimental groups

3.3 Authentic assessment using psychomotor by mentor of sample group: local expert.

The mentor of both sample groups was Thirasin: local expert who assessed skill, doing organic rice process and organic rice products of sample groups by observation and fill the psychomotor form.

The method of data collection consisted of:

1. The researcher creates the authentic assessment form following psychomotor concept to evaluate the organic rice farming skill and process of each sample by mentor of both sample groups as shown in **Table 3.4**.

Table 3.4 The authentic assessment form of organic rice farming skill and process for each sample

Activity	Practicing Performance			Performance	Process Performance Skill		
	Perception	Set (Readiness)	Guided Response	Mechanism	Origination	Adaptation	Complex overt response
Organic Rice Farming	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T1_Soil Analysis	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T2_Seed Selection	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T3_Seedling	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T4_Soil Preparation	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T5_Rice Planting	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T6_water management	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good

Table 3.4 The authentic assessment form of organic rice farming skill and process for each sample (Continued)

Activity	Practicing Performance			Performance	Process Performance Skill		
	Perception	Set (Readiness)	Guided Response	Mechanism	Origination	Adaptation	Complex overt response
T7_Disease, Pest and Weeds control	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T8_Harvest	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good
T9_Soil Development	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Correct/ Incorrect	Fail/ must be adjusted/ Pass/ Good	Fail/ must be adjusted/ Pass/ Good

The mentor of control and experimental groups who was Thirasin and researcher made observation and authentic assessment of each sample skill and process in organic rice farming. The evaluation form in **Table 3.4** was used to measure the organic rice skill and process of samples on organic rice farming performance. The expert’s (Thirasin) evaluation point definition was in **Table 3.5** to assess all samples in psychomotor in order to relate and measure sample performance skill with cognitive level of learning process.

Table 3.5 Performance and competency evaluation form for non-science and technology educated farmers in both control and experimental groups

Cognitive behavior indicator	Fail/not correct (0 points)	Fair/Correct need to adjust (1 points)	Pass (2 points)	Good (3 points)
Organic Rice Farming Task 1 – Task 9	• Could not answer all questions, • Could not understand experts, • Be not ready to do by their own, • Could not follow correctly experts' guidelines • Could not be origination • Could not respond any complex domain knowledge • Could not apply or modify domain knowledge	• Answers are not clear and get to the key words of correct answers, confusing answers • Could follow experts' guidelines but need to be adaptive work and output • Could be origination but need to be adaptive work and output • Could respond complex domain knowledge but need to be adaptive work and output • Could apply or modify domain knowledge but need to be adaptive work and output	• Answers get to the points of questions but it is still needed more detail • Could follow experts' guidelines and could respond complex domain knowledge • Could apply or modify domain knowledge	• Answers are complete and covered for all aspect of questions, clear answers • Could well follow experts' guidelines and could well respond complex domain knowledge • Could well apply or well modify domain knowledge

Table 3.6 Timeframe of effective tutorial social science ontology modeling on organic rice farming and learning process measurement by semantic annotation on Bloom's Taxonomy vocabulary

Process	2014												2015			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
1. Sample validation and selection	←—	—→														
2. Trainer Expertise qualification and Knowledge Capture and Knowledge Analysis			←—	——	—→											
3. Ontology identification and development				←—	—→											

Table 3.6 Timeframe of effective tutorial social science ontology modeling on organic rice farming and learning process measurement by semantic annotation on Bloom’s Taxonomy vocabulary (Continued)

Process	2014												2015			
	1	2	3	4	5	6	7	8	9	10	11	12	1	2	3	4
4. Learning process implementation • Design learning activity based on building learning organization • Tutorial social science and technology ontology knowledge • Training organic rice farming course					←	—	—	—	—	—	→					
5. Knowledge validation and learning process improvement measurement by semantic annotation on Bloom’s Taxonomy vocabulary												←	—	—	→	