

Role of Science Based Education for In-Depth Knowledge in Environmental Personnel Teaching in Secondary Schools for Clarifying on Community Garbage Disposal and Wastewater Treatment in Thailand

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Abstract

The objective of this paper is aimed to find the scientific knowledge to train the school teachers who take responsible for teaching community garbage disposal and wastewater treatment in parts of environmental classes and in the subject of cross curriculum in order to fill the gap of extension program belonging to the Royal LERD Project. Sixteen key knowledge issues were extracted from the Royal LERD Project in order to set 4 examination questions each issue for testing the science based education of 117 school teachers as the representatives of Uttaradit province, the Lower North of Thailand. After they failed of the test at Uttaradit Rajabhat University, all sets of 4 examination questions were modified to approach science based education in order to test the small-homogeneous group of 45 school teachers at Kong Kai Lad school in Sukhothai province, adjacent to the south of Uttaradit province, but it was not successful again because they were still weak in science for garbage and wastewater. There was no choice, the decision had to be made by improving the modified key knowledge issues to approach science based education towards science training program to clarify the community garbage disposal and wastewater treatment as final suggestion to train the environmental school teachers. There were 11 suggested subjects as follows: Solid Waste Management, Water Quality Management, Plant Physiology, Aquatic Plant, Thermo-osmosis, Organic Composting, Thermodynamics, Herbivore Fish Culture, Soil Science, Environmental Toxicology, and Environmental Designing.

1. Introduction

Thailand has been facing on big problems of garbage from households approximately 14.5 million tons per year and using sanitary landfill as official disposing technology along good land for agriculture in all parts of the country. Actually, not only losses of agricultural lands, but also contaminants have been found in adjacent areas and externalities of hazardous wastes, toxic chemicals, recycling materials, organic wastes. In general, the sanitary landfill should be the best garbage disposing technology in tropical-wet region like Thailand, but the performance never follows the effective principles. Perhaps, dumping the garbage on ground surface of disposing sites without care for every municipal and community would be the main cause of mentioned problems. Besides, burning would be another reason that can induce the problems of air pollution and disordered piling areas. However, the sanitary landfill is still a appreciate in tropical climatic condition of high humidity together with moist organic producing, only garbage separation is required for taking organic wastes to make the compost, recycle materials to manufacture, and hazardous wastes to dispose with proper technologies.

In spite of garbage disposal and wastewater treatment are really required science based education, the previous performance ignores in stead of taking it as main function for encouraging on effectiveness of sanitary landfill and wastewater treatment technologies as the same statements of Abdullah et al(2011), Breiting and Wiekenberg (2010), and Soykan(2009). To follow above statement, Berkun(2005), Adrian and Sanders(1998), Luderitz et al (2004), Tukker(2000), Minowa et al (1995), Berthier(2003), Yufeng et at (2003) and Vertacnik(1997) emphasized that the scientific knowledge on physics, chemistry, and biology are very necessary to train to managing personnel for understanding how organic digestion occur, how bacteria work, how heat release, how toxicants contaminate, how plant nutrients and also how hydrogen sulfide and methane as well as ammonia to exist during the digesting processes of organic wastes in community garbage disposal and wastewater treatment

Know-how to invent technology for disposal the organic, recycle, and hazardous wastes is required in-depth knowledge on natural science on every step of working processes since garbage making, collecting, piling, transporting, dumping, landfill excavating, and landfilling method. Understanding on the scientific properties of each piece of garbage would result in getting right way how to manage them, particularly separation, disposal method selection, leachate treatment, recycling processing, hazardous waste managing method, and know-how to transfer to environmental educators as well as environmental learners. Besides, basic scientific knowledge has it's own function to make clear understanding environmental experiences as obtained from field trip which is very necessary for environmental classes in formal education and also in non-formal education.

Based upon an evolving understanding of H.M. The King's initiative nature-by-nature concept (Royal LERD Project Annual Reports, 2004-2011), the basic principles were taken to find out the existing knowledge on garbage and wastewater and being eligible to find means how to add the weakness of science for clarifying knowledge on community garbage disposal and wastewater treatment from Petchaburi municipal. The details were described in Royal LERD Project Annual Reports (2004-2011), each of them can be condensed into 15 key knowledge issues as follows:

- (1) community garbage and disposal processes,
- (2) community wastewater and treatment processes,
- (3) photosynthesis and plant tissue building,
- (4) phytoplankton-algae and it's photosynthesis capacity,
- (5) thermo-osmosis process for oxygen transportation through very young leaf of aquatic plants,
- (6) organic material digestion,
- (7) thermo-siphon process for oxygen penetration to the lower levels through cooler water according to evaporation from pond water surface,
- (8) herbivore fish culturing for phytoplankton-agae growth balancing,
- (9) electron acceptors, paddy soils, and organic digestion,
- (10) design for community garbage disposal systems,
- (11) design for community wastewater treatment systems,
- (12) compost and nutrient content,
- (13) leachate from compost making processes,
- (14) gases releasing from digestion of organic wastes,
- (15) toxicity and detoxifying of community garbage and wastewater.

Each key issue is formed into 4 units (they become 4 examination questions for evaluation of science based education) of knowledge of garbage disposal and wastewater treatment basic science fields in microbiology, biology, physics, and chemistry, also some parts of following applied science, particularly ecology, soil science, aquatic plants, fisheries, forestry, physics^o of water, hydrology, engineering design, urban planning and management, toxicology, and agriculture.

Due to opinions of Guven and Aydogdu (2011), Hussan et al (2011), Kim (1999), Koizumi (2004) Lateh and Muniady (2010), Calskan (2011), Carleton-Hug (2010) and Yurttas and Sulun (2010), the previous research results showed some evidences that the school teachers who had natural science background somewhat good enough to transfer in-depth knowledge to students on environmental problems, especially crisis natural disasters of floods, drought, hot waves, global warming and/climate change, la Nina, el niño, landslide and mudflow, water pollution, air pollution, and solid waste management. Actually, the natural disasters as stated are needed specialization rather than few basic science courses of freshmen and sophomore classes but the school's teachers have to seek from non-formal education as well as searching from literature and update academic information (Yurttas and Sulun 2010, Urey et al 2009, and Suarez and Marcote 2010). Furthermore, Srbinovski et al (2010), Soykan (2009), Cloquell-Ballester et al (2008), Crohn and Birnbaum (2010) and Abdullah et al (2011) added more informative ideas that the environmental educators have to teach the students not only in classes but also gaining field experiences should be added in order to give them practicing. To accomplish the said statement, the school teachers who take responsibility of

environmental courses have to train themselves on both basic principles and know-how before teaching (Urey et al (2009) and Lateh and Muniady (2010)). To fulfill the scientific requirement of school teachers as environmental scientists, Vymazal (2009) finished on concerned research project to treat wastewater by using filtration plots with aquatic plant growing as phytoremediation concept under background of physics, chemistry, biology, toxicology and detoxification, and soil science. At the same trend, Vertacnik et al (1997) studied on solid waste disposal by composting, while Tukker (2000), Berkun (2005), and Royal LERD Project Annual Reports (2004 -2011) showed how to extract heavy metals of leachate from sanitary landfill by plants. It would be stated that community garbage and wastewater treatment are required both basic and applied sciences for school teachers in order to educate students.

Clear understanding on unsuccessfulness of formal and non-formal education in environmental learning how to dispose garbage and to treat wastewater from communities could be pronounced in terms of sustainable problems because of natural science knowledge weakness of school teachers and extension personnel. Performance after learning community garbage disposal and wastewater treatment found the successive programs only inside schools for formal education and few days for non-formal education. It was learnt that the in-depth knowledge could not be taken an account for such unsuccessful performance to manage garbage and wastewater from any sources. Although environmental learning curriculum of both formal and non-formal education has consecutively been improved but local and national problems of garbage and wastewater are still somewhat in the past time. To find means on how to solve the above description, this research hypothesizes that school teachers who are responsible for environmental classes should be the science based education persons rather than any ones like in the past.

The purposes of research on science based education for in-depth knowledge of school teachers for clarifying disposing processes to community garbage are, firstly, to determine teaching capacity in environmental courses on in-depth knowledge of garbage science for school teachers, secondly, to find out scientific knowing gaps of environmental education teachers in relation to interpretation efficiency on community garbage to science based education, and thirdly, to find means how to fill up the scientific knowledge gaps of school teachers who take responsible for environmental courses in schools.

2. Methods and Materials

- 1) Study closely to the technical reports and also field research works on The King's Initiative Project on Environmental Research, Study, and Development at Lam Phak Bia sub-district, Ban Lam District, Pechaburi Province, Thailand,
- 2) Form the examination questions of hidden-scientific knowledge through the community garbage disposal and wastewater treatment as taken from the King's Initiative Project on Environmental Research, Study, and Development of Lam Phak Bia Environment (Royal LERD Project) at Lam Phak Bia sub-district, Ban Lam District, Petchaburi Province, Thailand,
- 3) training and workshop at Uttaradit Rajabhat University on the scientific knowledge through community garbage disposal and wastewater treatment under the King's initiative nature-by-nature processes to 117 school teachers of as the environmental teaching representatives and being the

samples of the Lower North in Thailand,

- 4) after in-class training and field study, testing the hidden-scientific knowledge through community garbage disposal and wastewater treatment under the King's initiative nature-by-nature processes to 117 school teachers,
- 5) analyze and synthesize the tested papers for determine the the knowledge background of community garbage disposal and wastewater treatment, and also extract the hidden-science knowledge of 117 school teachers in order to obtain the direction for teasing the in-depth scientific knowledge of volunteer science-based teachers in relation to dispose garbage and to treat wastewater,
- 6) organize smaller training program for 10 science based teachers and 35 non-science based teachers as belonged to Kong Kai Lad School at Kong Kai Lad district in Sukhoththe province. Then one-day lecturing and test on new contents (improved contents from previous research at Rajabhat University) of the King's initiative nature-by-nature processes on community garbage disposal and wastewater treatment.
- 7) Determine the correct and incorrect scores of in-depth hidden science knowledge on key issues of community garbage disposal and wastewater treatment in order to find missing points and means how to compensate them.

3. Results and Discussion

3.1 Digesting Processes of Organic Wastes in Garbage and Wastewater under Royal Nature-by-Nature Concept

Due to the technical reports of Royal LERD Project Annual Reports (2004-2011) under H.M.the King's initiative nature-by-nature concept for community garbage disposal and wastewater treatment of Petchburi municipal in Petchaburi province since 1990, the highlight of such environmental research and development has been placed on natural technologies concerning how to take an oxygen from atmosphere to support an aerobe as energy supply in order to keep continuing the existing natural digesting processes of organic matters in garbage and in wastewater. As stated at the beginning, the 16 key issues of community garbage disposal and wastewater treatment are withdrawn under science based concepts that can be expressed the details as follows:-

3.1.1 Natural Technologies for Garbage Disposal

Fifteen concrete boxes (with the size of 1.5 x 2.0 x 3 m for depth, width, and length, respectively) were built at the project site on the upper part of mangrove forest along the seashore of Pechaburi province in Thailand. Following the soil science and microbiological principles, the box bottoms were paved with cause sand as placed on hole-made pipes which connected with box outlets for leachate draining from aerobic organic waste digestion for about 30 days to get final stage of mature compost. In working steps, it begins from putting 67-kg organic garbage (plenty of tropical microorganisms) into concrete boxes and spreading them at about 30-cm high over sand bed. Paddy soils (very fine) with high contents of electron acceptors (Fr, Mn, O, Nitrates, and others) have to pave about 5-cm high above organic waste surface. Second step is supposed to work out the same as the first step, while the third step is almost the same as steps one and two, but it only different on

paved paddy soils on the top at about 15-cm high together with permanently open boxes. Based on, biologically and physically, built-plant tissue accumulation the same time of connecting from small to large molecules with the chemical energy which is solar heat storage. When the organic digestion is occurred the released bacterial enzymes has a power to break bigger molecules of plant/animal tissues into smaller molecules, causing the chemical energy as heat to be released somewhat high temperature from 50 C to 77 C as found in the Royal LERD project of Petchaburi province. The highlight of this study pointed out that the more the carbohydrate and protein contents, the high temperature was indicated. The Royal technique has specified to watering at least 60 L/d in order to meet three objectives; firstly, for bringing electron acceptors to neutralize with extracted ions from digesting processes, secondly for bring dissolved oxygen as energy supply to aerobes to digest the organic matters, and finally for cooling the composting systems. In case of leachate occurrence because of excess watering and/or rain falling, it has to go down to the bottom and penetrates through hole-made pipes to the outlets and ending at leachate containers. Such leachate and also collected compost must be made the chemical analysis for identifying the contaminants such as plant nutrients, heavy metals, and another toxic chemicals for more beneficial utilization, especially for growing economic crops and furnishing soil fertility of disturbed mangrove forest as the King's objective from this project.

Close consideration could be pointed out that working on community garbage disposal was required somewhat good background in sciences (physics, chemistry, and biology) and its processes, and also applied sciences such as soil science, crop science, agriculture, garbage disposal, plant compost, wastewater treatment, phytoextraction, phytoremediation, and stream pollution as pointed out by Kim (1999), Koizumi (2004), Hussan and Ismail (2011), Wang and Peng (2010) and Vymazal (2009). Therefore, the teachers who takes responsible environmental courses and teaching in part of community garbage disposal, he/she is recommended to train himself/herself in natural science, at least sophomore class.

3.1.2 Natural Technologies for Wastewater Treatment

Normally, community wastewater is composed of physical, chemical, and biological materials in between molecules of water. In other words, water is never been rotten, water is still water even it is polluted by organic materials, diseases, chemicals, and debris from point sources of community, cities, industrial factories, livestock, cropping areas, and transportation. If all contaminants were extracted out, obtained clean water would be expected but appropriate technology was very difficult to select in the past. This is why Suvapeepun et al (1984) explained that the water pollution has been spread almost every river or canal in Bangkok and also in the whole country of Thailand, causing the decrease of fish population, increasing of water cleaning payment, and unpredictable-intangible losses.

H.M. The King has initiated community wastewater treatment under nature-by-nature concept likewise community garbage disposal by using three consecutive oxidation ponds and six of 5-m width, 100-m long, and 75-cm depth of grass filtration plot systems. Pumped wastewater (BOD 150-300 mg/L) 3,600 cubic meters per day are drained from Petchaburi to project site by HPDE pipes about 18.5 km and reducing BOD at about 70 mg/L. The ended HPDE pipe wastewater is separated into two parts, about 20 % goes to grass filtration plots and the another 80 goes to three consecutive oxidation ponds. Treatment processes are presumed to occur in wastewater above soil surface of

oxidation ponds and in soil under soil surface of grass filtration plots. Processes begin at the condition of releasing bacterial enzymes to break big molecules of tissues to smaller molecules, and turning to be inorganic substances as nutrients for growing phytoplankton and algae in oxidation ponds as well as for aquatic plant growing in grass filtration plots. Three herbivore fishes per square meter of water surface were allowed to raise in oxidation ponds and the catching age about 3 months, while harvesting time of grasses and aquatic plants about 90 days as arrived maximum capacity for chemical absorption (Royal LERD Project Annual Report (2004-2011)).

Following bacterial organic digestion, thermo-siphon process is the process of oxygen transfer from atmosphere near water surface of oxidation ponds to the depth at about 3 meters by cooling surface water because of absorbed latent heat of evaporation (583 cal/gm-water). Cooling water encourages higher density increasing, after that it sinks vertically down to the bottom by replacing the warmer water going above elevation (Royal LERD Project Annual Report, 2004-2012). At the same time, the existence of phytoplankton and another algal species can induce oxygen from atmosphere down to wastewater under photosynthesis process. Growing phytoplankton and algae are food source for herbivore fishes without feeding food to them. There is one more naturally oxygen can transfer from atmosphere to soils as energy supply for bacteria around root zone under the thermo-osmosis process. Highlight of this issue is to be concentrated on produced oxygen as obtained during photosynthesis processing of very young leaves of aquatic plants, which pertain the aerenchyma sponge cells can penetrate through very soft membrane then traveling along to tissues of piths and xylems to root zone as energy supply to soil bacteria in order to stimulate an organic matter digestion and becoming to inorganic nutrients for plant growth (Vymazal 2009, Harrison 1980, Wang and Penguin 2010), Berkun 2005, Luderitz et al 2004, McGrath and Lombi (2002), Cheevaporn and Menasveta (2003) and Kruawal et al (2005).

Close consideration in science based background found the same resolution, community wastewater treatment is really needed the person who knows well in science as the same as the statement belong to Lateh and Muniady (2010), Srbinovski et al (2010), Soykan (2009), Suarez and Marcote (2010), and Yurttas and Sulun (2010)). In so far, the teachers who teach an environmental part of wastewater treatment by biologically oxidation ponds and grass filtration systems should have background of natural science at least sophomore classes. However, it would be clearly understandable that natural science plays vital role in school teachers for teaching community garbage and wastewater treatment as well as another environmental subjects in order to protect solid waste problems and water pollution of the country.

3.2 Existing Knowledge of Uttaradit School Teachers

For being eligible of school teacher understanding community garbage disposal and wastewater treatment, the research was organized at Uttaradit Rajabhat University training the 117 school teachers who are teaching environment classes of grades 10, 11, and 12 of 16 schools in Uttaradit province. There were 66.3 % women and 33.7% men, averaging age about 43 years, and holding bachelor degree about 75%. The research has rearranged a half day of one-day lecture program under the content of the Royal technologies for community garbage disposal and wastewater treatment by grass filtration plots and oxidation ponds. In the afternoon, the key issues were paid more attention on the extraction on hidden-science principles to dispose home-community garbage and wastewater treatment.

The details of examination questions from 15 knowledge issues of the King's initiative community garbage disposal and wastewater treatment were tested to the 117 school teachers in Lower North on 15 March 2011. Surprisingly, there was no one passing score as shown in Table1, more than a half failed and the others confused some in-depth scientific knowledge. Actually, the tests after lecturing were not difficult in hidden-scientific background questions in the content of community garbage and wastewater. However, more than a half of non-science school teachers who take responsible for environmental courses were found not passing scores (Tables 1 and 2).

3.3 In-Depth Scientific Knowledge Requirement

As known among the scientists, environmental phenomena as the same trend as natural disasters are extremely needed scientific background for finding means how to make them sustainable. Unfortunately, the Lower Northern school teachers seemed less understandable science in which they could not extract an in-depth knowledge of community garbage disposal and wastewater treatment under the King's initiative nature-by-nature processes. Consequently, the problems of community garbage and wastewater cannot get rid of Lower North of Thailand as seen in the past and present time, maybe in the future.

It is so unhappy to state that the Thai school teachers have been assigned to take responsible for not only teaching but also cooking for serving lunch to the school kids, and guest relations to receive honorable high ranking government officials and also the foreigner guests. This is why the school teachers are very difficult to take themselves to catch up newly knowledge of changing global environment that moves rapidly in parallel with developing science. Another key point is that the representative schools in Uttaradit province are located far from capital city of Uttaradit about 80 km in radius and from Bangkok about 600 km, such a long distance might cause them to discourage of finding out environmental dynamisms as well as searching technical publications to get some new concepts in developing science managing community garbage and wastewater treatment under the King's initiative nature-by-nature processes as seen the success at Petchaburi municipal in Thailand.

Table1. Scoring of knowledge issues on community garbage disposal and wastewater treatment of school teachers who take responsible environmental teaching courses in Lower North of Thailand

No.	Knowledge-able Issues	Pass	Fail	Confusing
1	Community garbage and disposal processes,	-	-	C
2	Community wastewater and treatment processes	-	-	C
3	Photosynthesis and plant tissue building	-	F	-
4	Phytoplankton-algae and it's photosynthesis capacity	-	F	-
5	Thermo-osmosis process for oxygen transportation through very young leaf of aquatic plants,	-	F	-
6	Organic material digestion	-	F	-
7	Thermo-siphon process for oxygen penetration to the lower levels through cooler water according to evaporation from pond water surface	-	F	-
8	Herbivore fish culturing for phytoplankton-algae growth balancing	-	-	C

9	Electron acceptors, paddy soil, and organic digestion	-	F	-
10	Design for community garbage disposal systems,	-	-	C
11	Design for community wastewater treatment systems	-	-	C
12	Compost and nutrient content	-	-	C
13	Leachate from compost making	-	-	C
14	Gases releasing from digestion of organic wastes	-	F	-
15	Toxicity and detoxifying of community garbage and wastewater.	-	F	-
	Total	Nil	8F	7C

Remarks:

P =. Passing Score > 80 %

C. =. Confusing Score, mostly no answering the exam questions,

F. =. Failing Score < 80 %

Close consideration indicated that most of the correct answers were concerned with practical examination questions and they did not indicate any in-depth scientific knowledge on about disposing garbage and decreasing organic contaminant in water, such as designing for garbage disposal and wastewater treatment systems, garbage correction and transportation, and screening larger food waste materials. In addition, the scores of knowledge in less 80% of correct answers found only 30% , while more 80% found only correct answers 55% (Table 2). In other words, if the school teachers answered the examination questions with correct answers more than 80% items, the total correct answers would be on passing scores.As stated in previous sections that the school teachers who are science based education could be shown high eligibility to understand the in-depth knowledge on community garbage disposal and wastewater treatment, which is followed an information as given by Hassan and Ismail (2011).

Table 2. Knowledge issues being understandable to secondary school teachers in Lower North of Thailand

No.	Scores of Knowledge	Correct Answer of Knowledge Issue
1	less than 80% of correct answer	30% correct answers are examination questions
2	More than 80% correct answer	55% correct answers are non-science examination questions

3.4 In-Depth Scientific Knowledge Extraction

Theoretical point of view, community garbage and wastewater are in common of constituents of organic compound, water, microorganisms, and chemical elements but difference is identified on

quantity, recycle and solid wastes. In so far, the biological process is dominantly preceded by enzymes releasing of microorganisms, particularly bacteria, followings of organic digestion of bacterial enzymes under mainly chemical processes to break down of big and longer molecules of tissues into individual molecules in order that the chemical energy as molecule binding agent transferred to heat release by physical processes. Consecutively, the digested unit becomes warmer until heat as indicated high temperature up to 77 C in garbage piles but it is not serious condition in wastewater during digesting processes. The above statement is shown that garbage disposal and wastewater treatment proceedings are required basically natural science to clarify knowledge not only to garbage and wastewater management but also to the another environment such as air and noise pollution, floods, drought, natural resources, and sustainable designing. If not, the teachers who take responsible for environmental courses cannot show themselves as effective transferring personnel in environment, causing the target receiver group cannot accept a full detail of teaching. Consequently, wrong environmental behaviors of school kids would be with them until they grow up and problems of over burden garbage and wastewater could not be solved forever.

According to the training program on community garbage and wastewater was organized in big group of school teachers at Uttaradit Rajabhat University and results found school teachers weak in science based education when they were in undergraduate classes, both science and non-science students in the past. Problems of garbage and wastewater could be evident not only in Lower North but also in the whole country such as disordered sanitary landfills and lower standard of effluent from factories and communities. Based on the failed scores of school teachers from examination as done at Uttaradit Rajabhat University, the training program would be too big, lecturing might not be effective. To prove the effectiveness of lecture on too in-depth science of community garbage disposal and wastewater treatment, the research was paid attention in small and homogenous group of school teachers by selecting 45 persons from only Kong Kai Lad school at Kong Kai Lad district in Sukhothai province as belonged to the Lower North of Thailand too. Unfortunately, although the knowledge content of community garbage disposal and wastewater treatment was improved by rearranging the key issues of natural science to add in examination questions, the school teachers could not obtain the passing scores as shown in Table 3. It is quite evident that school teachers cannot obtain the pawing scores, even the contents of lecture and examination questions ave been improved to go hand in Han between in-depth

Table 3. Scientific knowledge related to community garbage disposal and wastewater treatment of secondary school teachers in Lower North of Thailand

No.	Scientific knowledge.	Correct	Incorrect
1.	Basic knowledge of fundamental. Science of the whole class(45 persons)	75.%	25%
2.	Science based teachers(10 persons)	79%.	21%
3.	Non-science based teachers(35 persons)	74%.	26%

Science knowledge and the content of community garbage and wastewater. Surely speaking, although the details of knowledge has improved to pave way to natural science based curriculum for community garbage and wastewater education, misunderstandings are still shown (Table 3).

The school teachers in the Lower North are very weak in fundamental science as indicated the examination scores only 75% which is failed (Table 3). Also, the incorrect answers obtained the examination scores 25%, such mistake should not belong to a school teachers who is supposed to get better scores. For clearly understanding, the evaluation of science based teacher scoring found incorrect answers 79% and still under passing scores, but the incorrect answers looked better scores of 21%. It cannot believe that the science trained teachers of Kong Kai Lad school are somewhat weak in hidden-science of community garbage and wastewater.

An incorrect answer was averaged about 25% from the whole class, 21% from science based teachers and 26% for non-science based teachers (as shown in Table 3). Careful study on incorrect answers from all examination questions were co owed of more or less basic natural science which extracted from the in-depth knowledge of community garbage disposal and wastewater treatment and also their organic digestion processes. Such statement would be pinpointed that school teachers, both science and non-science based education, are low capable to apply basic science to clarify the in-depth understandings on environment, especially garbage and wastewater from communities. It could not be avoided to mislead their environmental content to student one way or another.

3.5 Hidden Science In Community Garbage and Wastewater

In fact, hidden science in community garbage and wastewater was conducted since after finishing training program at Uttaradit Rajabhat University, and finally at Kong Kai Lad school. The academic content of 15 key issues on community garbage disposal and wastewater treatment as well as their organic digestion processes was used for extracting into 4 examination questions by dividing to 3 natural scientific questions (biology, chemistry and physics) and 1 applied scientific questions. The necessary science for understanding on community garbage disposal and wastewater treatment have been formulated in 10 fields of science and 1 environmental design as shown in Table 4. The details of each field are as follows:-

1) Solid Waste Management: in the content of garbage, points sources, disposal methodology, disposal processing, fermented garbage quantity and quality, and zero waste management.

2) Water quality Management: in the content of wastewater, point sources, types of wastewater treatment, treatment processes (physical, chemical, and biological processes), organic waste digestion, plant nutrient end-products, toxic chemicals (heavy metals, pesticides, insecticides, herbicides, fungicides), coliform bacteria, fecal bacteria, sommolella, E.coli, nematodes, paramecium, and debris.

3) Plant Physiology: in the content of photosynthesis, tissue building-up, soil nutrient up-taking, chemical energy as solar heat storage in plant tissues, growth and growth rate, and thermo-osmosis process.

4) Aquatic Plant: in the content of physiological characteristics, regeneration, floating aquatic plants, submerged aquatic plants, emerged aquatic plants, nutrient supply, water quality, growth

rate, aging, role in water quality, beneficial food for herbivore fishes, and aquatic ecology.

5) Thermo-osmosis Process: in the content of irreversible thermodynamics, heat exchange, oxygen transfer to root zone, sponge cells/aerenchyma cells, very young leaf, photosynthesis, rhizosphere, oxygen diffusion, natural-by-nature processes.

6) Organic Composting: in the content of organic waste, digesting bacteria, digesting processes, gases (carbon dioxide, ammonia, methane, etc.), heat releasing, leachate, nutrient content, toxic chemicals, diseases, organic garbage compost, heat storage, and compost texture.

7) Thermodynamics: in the content of heat transfer, evaporation to cool water, cooler water moving down to lower level, hotter water moving up to replace, cooler water pertaining more dissolved Oxygen, influencing higher air above water surface to press cooler surface water to the bottom, and more concentration of organic wastes causing more heating to water.

8) Herbivore Fish Culture: in the content of herbivore fish species, age of care-taking before letting free to wastewater treatment ponds, number of fish per surface area to survive in wastewater treatment ponds, catching age, phytoplankton feeding rate, and balancing between growth rates of fish and phytoplankton.

9) Soil Science: in the content of paddy soil, soil texture, clayed particles and ion adsorption, electron acceptors, soil fertility, soil moisture, soil water absorption, leaching process, soil porosity, heat transfer in soil profile, and organic matters in soils.

10) Environmental Toxicology: in the content of toxicity, detoxifying, chemical toxicants in garbage and wastewater, toxic chemicals in sludge/sediment and plant compost, toxicological processing, toxicant contamination in treated wastewater, and phytoremediation from toxic sediment and compost.

11) Environmental Designing: in the content of fundamental of design, designs for garbage disposal and wastewater treatment systems, principles of urban design, and sustainable design/environmental design, landscape design.

Table 4. Scientific content as extracted from community garbage disposal and wastewater treatment after accomplishing the training program at Kong Kai Lad School at Kong Kai Lad District in Sukhuthai Province

No.	Knowledge from Community Garbage and Wastewater	Science for Garbage Disposal and Wastewater Treatment
1	community garbage and disposal processes	Solid Waste Management
2	community wastewater and treatment processes	Water Quality Management
3	photosynthesis and plant tissue building	Plant Physiology
4	phytoplankton-algae and it's photosynthesis capacity	Aquatic Plant
5	thermo-osmosis process for oxygen transportation through very young leaf of aquatic plants	Thermo-osmosis Process
6	organic material digestion	Organic Composting
7	thermo-siphon process for oxygen penetration to the lower levels through cooler water according to	Thermodynamics

	evaporation from pond surface	
8	herbivore fish culturing for phytoplankton-algae growth balancing	Herbivore Fish Culture
9	electron acceptors, paddy soil, and organic digestion	
10	design for community garbage disposal systems	Environmental Designing
11	design for community wastewater treatment systems	Environmental Designing
12	compost and nutrient content	Soil Science
13	leachate fro composting making	Organic Composting processes
14	gases releasing from digestion of organic wastes	Organic Composting
15	toxicity and detoxifying of community garbage and wastewater	Environmental Toxicology

The 11 key knowledge fields which were explained above would be applicable for any training program on community garbage disposal and wastewater treatment with the descriptive details of each field of science and designing in Table4. Practically, the mentioned details have to rearrange in academic forms as the same as the consecutive topics in order to simplify and to clarify the knowledge of community garbage disposal and wastewater treatment for school teachers in the whole country of Thailand. However, it should remark here that the lecture time has to be around 5 hours, one and a half hour for answering the examination questions. For sure, the lecturers must be full of experiences in each field because of being capable to digest the short details, also withdrawing some important content issues of such fields to transfer for clear understanding to the school teachers. Hopefully, each school teacher would gain more benefits to transfer the knowledge of community garbage disposal and wastewater treatment which make them not only knowing but also conducting and solving problems.

4. Conclusion

The research has been decided into two phases; firstly, the key knowledge issues of community garbage disposal and wastewater treatment were extracted for setting up 4 examination questions to test 117 environmental school teachers of Uttaradit representatives. After they failed the test, the examination questions were modified more likely to science based education and using it to test 45 teachers of Kong Kai Lad school in Sukhothai province but they could not obtain the passing grade. Perhaps, the science of garbage disposal and wastewater treatment might be so difficult for them, then the key knowledge issues were improved to approach to science based education. There was no other way to do, only taking the second phase had to extract the key knowledge issues of community garbage disposal and wastewater treatment into science based application for 11 subjects; such as solid waste management, water quality management, some parts of plant physiology and thermodynamics as the same as soil science and environmental toxicology, osmosis process, organic composting, herbivore fish culture, and environmental designing.

5. References

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