The Social Sciences 5 (1): 16-20, 2010
ISSN: 1818-5800

A Development of a Learning Resource of Solid Wastes and Wastewater Managements from Communities

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Abstract: At present the environmental problems concerning with the management of solid wastes and wastewater both locally and nationally, in part resulting from people's lack of suitable learning resources for the management of solid wastes and wastewater. Therefore, the researcher was interested in developing the learning resources for the management of solid wastes and wastewater from communities. The purposes of this study were: to develop an effective learning resource for the management of solid wastes and wastewater from communities, to develop training plans for management of solid wastes and wastewater through the learning resource, to compare the knowledge and attitudes toward the management of solid wastes and wastewater from communities before and after the training and to compare the knowledge and attitudes toward the management of solid wastes and wastewater from communities of the second-year students with different sexes and courses of study at Ubonratchathani Rajabhat University. The sample consisted of the 80 2nd year students: 40 male students and 40 female students; 20 students each, majoring in B.Ed., B.A., BB.A. and B.Sc. degree courses. The t-test and the F-test (Two-way MANCOVA) were employed for testing hypotheses. The findings of the study were as follows: Firstly, the developed learning resources model for the management of solid wastes and wastewater emphasized, simplicity, economy, convenience and practical uses. The appropriateness of the learning resources was at the more level as evaluated by the experts and visitors. Secondly, the training model was at the most appropriate level as assessed by the experts. Also, materials and handbooks on training of management of solid wastes and wastewater were at the most appropriate level. Thirdly, the students as a whole and as classified by sexes and courses of study showed gains in knowledge and attitudes toward management of solid wastes and wastewater in general and in two subscales: solid wastes management and wastewater management, from before training at the 0.01 level of significance. The students with different degree courses indicate only the knowledge of management of solid wastes and wastewater ($p<0.017$). In summary, the developed learning resources for management of solid wastes and wastewater from community was appropriately effective for being as part of training, which could increase students' knowledge and attitudes toward solid wastes and wastewater management. Involved persons should be encouraged and supported to implement this learning resources of solid wastes and wastewater management for other students and groups of people.

Key words: Learning resource, solid wastes management, wastewater management, training, knowledge, attitude

INTRODUCTION

In the present, environmental problems are very serious to Thailand and other regions of the world. Most of the problems are concerned with the quantity of solid wastes and wastewater from direct human activities. The Office of Natural Resources and Environmental Policy and Planning (2005), Ministry of Natural Resources and Environmental of Thailand reported environmental conditions in 2003 that the country had produced 39,240 tons of solid wastes per day in average, increasing from 2002 with 39,225 tons. The solid wastes had been managed in 4 methods, namely, collecting, transporting, reforming and destroying. In each method there were some problems, for example, the solid wastes were too scattered to collect properly. Moreover, the solid wastes were dumped without classification. The problem of transporting was lack of solid waste cars. The organic wastes could not be correctly applied. Some of them were not hygienically destroyed. They were dumped on land, at sea, or open burning. Open burning caused air pollution, which effected global warming and climate

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changes. The sources of wastewater were from communities, factories and agricultural activities. In evaluating water usage of community, a person uses 200 L of water per day, of which 80% or 160 L of water was wasted (Natural Resources and Environmental Policy and Planning, 2008). Without suitable management or treatment, there will be serious effect on lives in water and environment.

From the reasons, there should be development of learning resources on solid wastes and wastewater with the methods of simplicity, saving, convenience and application in daily lives. People and students can learn, practice, be skilled and have positive attitudes towards solid wastes and wastewater management, including problem solving behavior on solid wastes and wastewater (Veeravatnanon, 2003).

Purposes of the research:

- To develop learning resources on solid wastes and wastewater from communities
- To develop training plan on solid wastes and wastewater from communities, by using learning resources
- To study and compare learning achievements and attitudes toward solid wastes and wastewater management from communities before and after training of students as the whole, sexes and courses of study classification
- To study and compare learning achievements and attitudes toward solid wastes and wastewater management after training of students with differences in the sexes and courses of study

MATERIALS AND METHODS

Design and sample: The research was carried out using quantitative research. The data were collected from 400 second year students of 4 faculties, studying life and environment subject in the first semester of academic year 2008, Ubonratchathani Rajabhat University. Eighty samples were selected from students in Bachelor of Education degree course (B.Ed.), Bachelor of Arts degree course (B.A.), Bachelor of Business Administration degree course (BB.A.) and Bachelor of Science degree course (B.Sc.), 20 students for each course, classified as 10 males and 10 females by stratified random sampling.

Research materials and instrument: The research instruments included the training plans for the management of solid wastes and wastewater, the test on knowledge of management of solid wastes and wastewater and the attitudes toward the management of solid wastes and wastewater. An inventory to evaluate learning resources was constructed in the 5 rating scale with most, more, moderate less and least on solid wastes and wastewater management, model of training on solid wastes and wastewater management consisted of: define purpose, set training activities and evaluation. An evaluative inventory of 5 rating scale was constructed and checked up by the experts. Attitude inventory towards solid wastes and wastewater management. Likert attitude inventory of 5 rating scale was constructed with 24 items on solid wastes and 24 items on wastewater management. The tool was checked up by the experts, improving, try out and find out reliability by the method of Cronbach's alpha coefficient. A knowledge test of multiple choices with 60 items was constructed, being classified as: 30 items of solid wastes management and 30 items of wastewater management. The tool was checked up for improving, try out and find out reliability by the method of KR20.

Data collection and analyses: The training model for solid wastes and wastewater management, using the TPCEDTE model, consisted of 7 stages: needs for training, formation of purpose, selection of content, construction of evaluation forms, development, training and evaluation. Data processing on training achievement consisted of: knowledge test on solid wastes management and knowledge test on wastewater management and attitude inventory on solid wastes and wastewater management. The t-test and the F-test (Two-way MANCOVA) were employed for testing hypotheses.

RESULTS AND DISCUSSION

Learning resources development on solid wastes and wastewater management

Learning resources development on solid wastes management: One bin was used collect solid wastes with the quantity of 0.653 kg day^{-1} and producing rate of 0.131 kg/person/day. The solid wastes were classified into 3 types, namely, general solid wastes with 14.09 kg (77.12%), organic solid wastes with 4.02 kg (22%) and hazardous solid wastes with 0.16 kg (0.88%). Recycle solid wastes were classified as metal (0.94 kg), plastic (1.58 kg) paper (2.8 kg) and glass bottle (10.1 kg), with the price of 76 baht (Table 1).

Organic solid wastes were transformed into fermented fertilizer, consisting of nitrogen 0.26-0.33% ($\bar{X}$ = 0.29%), phosphorus 0.29-0.58% ($\bar{X}$ = 0.50%) and potassium 0.33-1.07% ($\bar{X}$ = 0.81%) by weight (Table 2).

Organic solid wastes were transformed into biotic fermented solution, consisting of nitrogen 0.32-0.60% ($\bar{X}$ = 0.42%), phosphorus 0.04% ($\bar{X}$ = 0.04%) and potassium 0.56-0.84% ($\bar{X}$ = 0.70%) by weight (Table 2).

Table 1: Solid wastes classification at learning resources

	Solid wastes classification		
Solid waste	General	Organic	Hazardous
Quantities (k.k.)	14.09 (77.12%)	4.02 (22.00%)	0.16 (0.88%)

Table 2: Quantities of macro nutrient in fermented fertilizer and biotic fermented solution

	Quantities of macro nutrient		
Macro nutrient	Nitrogen	Phosphorous	Potassium
Fermented fertilizer	0.26-0.33 ($\bar{X}$ = 0.29)	0.29-0.58 ($\bar{X}$ = 0.50)	0.33-1.07 ($\bar{X}$ = 0.81)
Biotic fermented solution	0.32-0.60 ($\bar{X}$ = 0.42)	0.04-0.04 ($\bar{X}$ = 0.04)	0.56-0.84 ($\bar{X}$ = 0.70)

Leaning resources development on wastewater management: The quantity of wastewater was 800 L day^{-1}, with the producing rate of 160 L/person/day. The wastewater in the buildings was collected into grease trap well, wastewater was analyzed by standard method (APHA, AWWA and WEF, 1995), consisting of BOD 105.7, TKN 117.6, P 6.72, S 6.6, SS 140.8 and FOG 128.08 mg L^{-1} (Table 3).

The wastewater after having been treated by the methods of grease trap well, facultative well and wetland system, consists of BOD 17.22, TKN 32.85, P 1.34, S 1.19, SS 36.25 and FOG 19.42 mg L^{-1} (Table 3).

Learning resources model on solid wastes and wastewater management: Learning resources on solid wastes management consisted of equipments, materials and documents on solid wastes collection, solid wastes separating and transforming, solid wastes destroying, fermented fertilizer preparation and biotic fermented solution preparation. Learning resources on wastewater consisted of equipments, materials and documents on wastewater collection, water savings, wastewater treatment, wastewater problem solving and wetland wastewater treatment.

Evaluation of learning resources: The learning resources on solid wastes management were evaluated by the experts and visitors at more level as the whole and the learning resources on wastewater management were also evaluated at more level as the whole (Table 4).

Training plan development on solid waste and wastewater management:

- Training model evaluation
- The experts evaluated training model on solid wastes and wastewater management at the most level as the whole
- Documents-training handbook evaluation
- The experts evaluated document-training handbook on solid wastes and wastewater management at the most level as the whole (Table 5)

Table 3: Property of wastewater from activities at learning resources

	BOD	TKN	P	S	SS	FOG
Property of wastewater	(mg L^{-1})					
Before reatment	105.70	117.60	6.72	6.60	140.80	128.08
After treatment	17.22	32.85	1.34	1.19	36.25	19.42

Table 4: Evaluation suitable of learning resources towards solid wastes and wastewater management

	Experts (n = 3)			Visitors (n = 30)		
Management	$\bar{X}$	SD	Level	$\bar{X}$	SD	Level
Solid wastes	4.000	0.000	More	4.419	0.385	More
Wastewater	4.146	0.095	More	4.496	0.373	More

Table 5: Evaluation of training model and documents-training handbook

	Experts				
Evaluation	1	2	3	Average	Level of suitable
Training model	34	33	34	4.81	Most
Document-training handbook of solid wastes	27	29	29	4.72	Most
Document-training handbook of wastewater	27	27	28	4.56	Most

Results of training students on solid wastes and wastewater management: The whole students, sexes courses of study classification had higher learning and attitude toward solid waste and wastewater management including solid waste management and wastewater management after training than before training with statistical significance at 0.01 level (Table 6).

There was no relation between sexes and courses studying of the students. The students with difference in sexes did not have different learning achievement and attitude towards solid waste and wastewater management after training. The student with different in courses of study had different learning achievement with statistical significance ($p<0.01$) (Table 7).

Learning resources development on solid wastes and wastewater management in learning resources area Learning resource development on solid wastes management: Learning resource on solid wastes consisted of equipments, materials and document on collecting, separating and transferring, destroying and fermented fertilizer and biotic fermented solution producing, with simplicity, saving and convenience in application. The visitors could gain knowledge and practice (Chunkeaw, 2002). The fermented fertilizer from organic solid wastes consisted of nitrogen 0.26-0.33% ($\bar{X}$ = 0.29%), phosphorus 0.29-0.58% ($\bar{X}$ = 0.50%) and potassium 0.33-1.07% ($\bar{X}$ = 0.81%) by weight. The quantities of phosphorus and potassium were higher than organic fertilizer standard of Department of Agriculture in Thailand about 0.5%, but the quantity of nitrogen was lower about 1.0%. The biotic fermented solution consisted of nitrogen 0.32-0.60% ($\bar{X}$ = 0.42%), phosphorus 0.04%

Table 6: Comparison of learning achievement and attitude towards solid wastes and wastewater management of whole students before and after training

Learning achievement	Management	Before training (N = 80) $\bar{X}$	SD	After training (N = 80) $\bar{X}$	SD	t	p-value
Knowledge	Solid wastes (score = 30)	12.713 (42.38%)	3.383	16.825 (56.08%)	3.617	-10.721	0.000**
	Wastewater (score = 30)	15.050 (50.17%)	3.855	18.913 (63.04%)	3.917	-9.913	0.000**
	Total (score = 60)	27.763 (46.27%)	6.047	35.738 (59.56%)	6.519	-14.748	0.000**
Attitude	Solid wastes	3.484[3]	0.367	4.295[4]	0.325	-14.368	0.000**
	Wastewater	3.494[3]	0.390	4.358[4]	0.312	-16.022	0.000**
	Total	3.489[3]	0.361	4.327[4]	0.298	-16.051	0.000**

**Significance at 0.01 level

Table 7: Comparison of learning achievement and attitude towards solid wastes and wastewater management of students with different sexes and courses of study (two-way MANCOVA)

Sources of variance	Dependent variable	Hypothesis df	Error df	F	p-value
Sexes	-	2	69	3.302	0.043
Courses of study	2	6	140	2.984	0.009**
Sexes courses of study	-	6	140	0.895	0.500

**Significance at 0.01 level

($\bar{X}$ = 0.04%) and potassium 0.56-0.84% ($\bar{X}$ = 0.0.70%), by weight. The quantities of nitrogen and phosphorus were lower than standard, but the quantity of potassium was higher than standard.

Learning resource development on wastewater management: Learning resource on wastewater management consisted of equipments, materials and document on collection, water saving, wastewater treatment, waste water problem solving and wastewater treatment with wetland system and other systems, with simplicity, saving and convenience in application. The visitors could gain knowledge and practice. After having been treated by standard methods (APHA, AWWA and WEF, 1995), the water was qualified with BOD 17.22, TKN 32.85, P 1.34, S 1.19, SS 36.25 and FOG 19.42 mg L^{-1}. The quality of water was in standard criterion of building effluent standard in Thailand, type D (except for SS-value) with the efficiency in treatment of BOD 82.88%, TKN 72.07%), P 80.06%, S 81.97%, SS 74.25% and FOG 84.34% (Udomsinroj, 1999).

Learning resource models on solid wastes and wastewater management: Learning resources on solid wastes and wastewater consisted of equipments, materials and documents on solid waste collection, separating and transforming, destroying, fermented fertilizer and biotic fermented solution producing. Learning resource on wastewater management consisted of equipments, material and documents on wastewater collection, water saving, wastewater problem solving and wastewater treatment with wetland and other systems.

Evaluation on learning resources: The experts and visitors evaluated learning resources on solid wastes management with higher level of suitability ($\bar{X}$ = 4.00 and 4.41) and evaluated learning resource on waste water management with higher level of suitability ($\bar{X}$ = 4.416 and 4.496).

Development of training plan on solid wastes and wastewater management

Evaluation on training model: The experts evaluated training model on solid wastes and wastewater by the method of TPCEDTE with the highest level ($\bar{X}$ = 4.81) of suitability as the whole, considering the aspects, every step was evaluated with the highest level, but step 6 was evaluated with more level.

Evaluation on training document-handbook: The experts evaluated training document-handbook on solid waste with the highest level ($\bar{X}$ = 4.72) of suitability as the whole. The quality of document-handbook was evaluated with the highest level ($\bar{X}$ = 4.75) and the usefulness was also evaluated with the highest level. The experts evaluated training document-handbook on waste water management with the highest level ($\bar{X}$ = 4.56) as the whole. The quality of document-handbook was evaluated with the highest level ($\bar{X}$ = 4.50).

Results of training students on solid wastes and wastewater management: The whole students, sexes and courses of study classification, had higher learning achievement and attitude toward solid wastes and wastewater management after training than before training, including two aspects of solid wastes management and wastewater management, with statistical significance at 0.01 level. This result indicated that learning was most effective when it could be applied in practice and life (Chanaboon, 2000).

There was no relation between sexes and courses of study. The students with difference in sexes did not have different learning achievement and attitude towards solid wastes and wastewater management after training, this indicated that students with difference in sexes had the same style of learning (Kammanee, 2005). The sexes therefore did not effect the learning of students on solid wastes and wastewater management and did not have relation with the courses of study. The students with

difference in courses of study had different learning achievement with statistical significance ($p<0.17$) in one aspect that was learning, the students which study on majoring in BB.A., B.Sc. and B.Ed. had learning achievement higher than B.A. This indicated that the courses of study effected learning on solid wastes and wastewater management.

CONCLUSION

The development of learning resources on solid wastes and wastewater management were the simplicity, saving, convenience and applicability. The 1,500 m^2 area consisted of equipments, materials and documents on solid wastes and wastewater management. The experts and visitors evaluated leaning resource on solid wastes and wastewater management with higher level of suitability.

The training plans of learning resources on solid wastes and wastewater were evaluated by the method of TPCEDTE with the highest level of suitability as the whole. The training document-handbook on solid wastes and wastewater were evaluated with the highest level of suitability.

The whole students and sexes and courses of study classification had learning and attitude towards solid wastes and wastewater management, including solid wastes management and wastewater management classification, after training higher than before training with statistical significance at 0.01 level.

There was no relation between sexes and courses of study. The students with difference in sexes did not have different learning achievement and attitude towards solid wastes and wastewater management after training. But the students with difference in courses of study had different learning achievement with statistical significance ($p<0.017$), in the aspect of learning.

Effective development of learning resources in solid wastes and wastewater management could be used in training. The students therefore could gain knowledge and attitude towards solid wastes and wastewater management. The model of learning resources development and training should be supported and promoted to other groups of people.

ACKNOWLEDGEMENTS

The researchers express their sincere appreciation for all of support provided and the referees for their helpful comments.

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