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Development of a training manual: An application of king's science to forest conservation in Thailand

Yanapat Chaloeisuk, Adisak Singseewo *, Sombat Appamaraka

Faculty of Environment and Resource Studies, Mahasarakham University, Kham Riang, Thailand

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ABSTRACT

This study aimed to develop and evaluate a training manual for implementing king's science in forest resource conservation at Nong Khu and Na Dun national forest reservation sites, Na Kha Sub-district, Wapi Pathum District. The research engaged 30 community leaders from adjacent communities as participants. The methodology included a pre-and-post training assessment of knowledge and attitudes toward forest conservation. Research instruments comprised a training manual, guidelines for applying king's science in forest conservation, and an attitude test. Statistical analyses involved frequency, percentage, mean, standard deviation, t-test, and one-way ANOVA for hypothesis testing. Key findings revealed a significant increase in knowledge and positive attitudes towards forest conservation post-training, evidenced by an efficiency rating of 85.42/81.80 and an effectiveness index of 0.6623, indicating a 66.23% improvement in villagers' understanding of king's science application. Furthermore, post-test scores in both knowledge and attitudes significantly exceeded pre-test scores, confirming the training's impact.

1. Introduction

Presently, the condition of natural resources and the environment imposes significant limitations on sustaining production, services, and lifestyles. The relentless overexploitation of natural resources results in continuous degradation and increasing soil erosion (Reed et al., 2009). This trend places biodiversity in peril and results in a scarcity of water resources, potentially leading to future shortages. The rapid economic growth and urbanization are further escalating conflicts over natural resource utilization, unfair resource allocation, and environmental issues, negatively impacting life quality and economic stability (Zucaro et al., 2022). Moreover, climate change and natural disasters, especially floods and droughts, have become more unpredictable and severe, affecting various economic sectors and the domestic production chain (Tabari, 2020). In response, international climate change agreements are intensifying, necessitating Thailand's preparedness to reduce greenhouse gas emissions amidst global trade competition (Chaichaloempreecha et al., 2022). Thailand is thus obliged to consider the 15-year global sustainable development strategies (2016-2030) in shaping its future national development guidelines. The 12th Development Plan of Thailand needs to prioritize the stabilization of natural resources and the enhancement of environmental quality to foster green growth and improve people's quality of life (Assarkhaniki et al., 2023). This involves addressing environmental crises, minimizing pollution from production and overconsumption, establishing a transparent and equitable management system, promoting eco-friendly production and consumption practices, preparing for greenhouse gas emission reduction, and augmenting climate change adaptability. Moreover, formulating strategies to reduce natural disaster-related risks is imperative (Sudmeier-Rieux et al., 2021).

Satellite imagery of Thailand's forest area in 2016 (Royal Forest Department) revealed a forest cover of only 31.58%, a slight decrease from the previous year (Kiguchi et al., 2021). Regional analysis indicated that the northern region possessed the most forested area, followed by the western, southern, eastern, central, and northeastern regions. Since 1961, the eastern region experienced the steepest decline in forest area. King Bhumibol Adulyadej's "science," a comprehensive approach integrating behavioral science, education, health,

* Corresponding Author.
Email Address: adisak.s@msu.ac.th (A. Singseewo)
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Corresponding author's ORCID profile:
https://orcid.org/0000-0003-4633-2425

productivity research, risk management, natural conservation, and self-reliance, promotes a sustainable quality of life and national development through good governance (Sookngam et al., 2021). This philosophy encourages community-based learning and development, considering environmental and social values. His Majesty's approach to environmental stewardship emphasizes the interconnectedness of nature, soil, water, forests, and living organisms, advocating for maintaining ecological balance through natural processes.

Environmental education is crucial in fostering public awareness, responsibility, and active participation in addressing environmental problems. It should focus on real-world issues, problem-solving, and instilling a sense of selflessness and responsibility towards the environment (Cheung et al., 2021; Alshuwaikhat and Abubakar, 2008). In this context, the researchers were motivated to develop a training manual that incorporates king's science for forest resource conservation. The objective is to evaluate changes in the knowledge and attitudes of the participants post-training, thereby contributing to environmental preservation efforts.

The research objectives can be summarized as follows:

1. To construct a comprehensive training manual that effectively utilizes the principles of king's science for the enhancement of forest resource conservation, ensuring optimal efficiency and productivity.
2. To conduct a comparative analysis of knowledge levels pertaining to the application of king's science in forest resource conservation, assessing the impact of training by comparing pre-training and post-training knowledge states.
3. To undertake a comparative evaluation of attitudes towards the application of king's science in forest resource conservation, measuring changes in attitudes before and after the training intervention.

The research hypotheses can be summarized as follows:

1. The objective was to develop a training manual within the scope of this research that would achieve an efficiency and productivity benchmark of 80/80.
2. It was hypothesized that the knowledge regarding the application of king's science in environmental protection among community leaders residing in the vicinity of the Nong Khu-Na Dun National Forest Reservation site, Na Kha Sub-district, Mueang District, Maha Sarakham Province, would significantly improve following the training, achieving statistical significance at the .05 level.
3. Similarly, it was anticipated that the attitudes towards the application of king's science in environmental protection among these community leaders would exhibit a significant enhancement post-training, with this change also reaching statistical significance at the .05 level.

Within the conceptual framework of this research, the methodology was segmented into five distinct phases, as illustrated in Fig. 1. Phase 1 involved the design of the king's science training manual. Phase 2 encompassed the evaluation of the efficiency of the king's science training manual. In Phase 3, the development of the king's science training manual tools was undertaken, which included the creation of a comprehensive king's science training manual comprising five modules, alongside the formulation of associated tests and an attitude questionnaire. Phase 4 was dedicated to the evaluation of the king's science training manual tools. Finally, Phase 5 entailed the implementation of the king's science training manual tools with a sample of 30 participants.

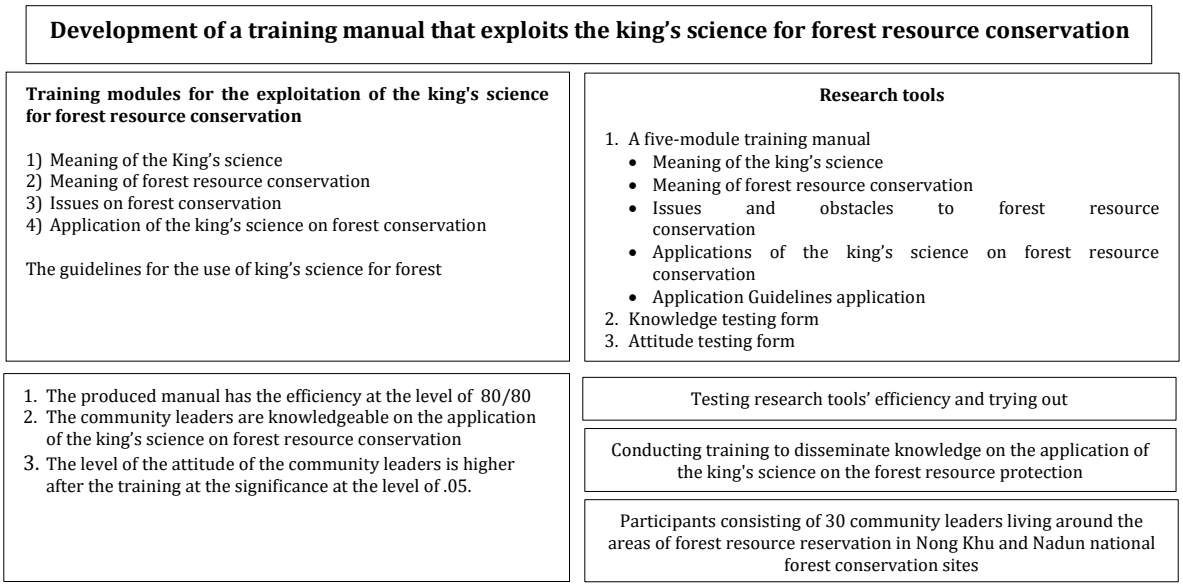

Fig. 1: Conceptual framework

2. Research design and method

The research design and methodology employed an experimental framework, as depicted in Fig. 2. This involved a single-group pre-test-post-test design. 'O_1' represented the evaluation of the pre-training phase, while 'O_2' denoted the evaluation of the post-training phase. The variable 'X' in this framework was indicative of the training model implemented within the study.

O_1	X	O_2
O_1= Variable value before the training; X= The training; O_2= Variable value after the training; The research was conformed with the one-group pre-test-post-test design		

Fig. 2: Research design and method

2.1. Population and sample

The research population comprised a cohort of 90 community leaders, drawn from six villages with each village contributing 15 individuals. These participants were situated in the vicinity of the Nong Khu-Na Dun National Forest Reservation site, located in Na Kha Sub-district, Mueang District, Maha Sarakham Province. From this population, a total of 30 samples were meticulously selected employing a specified selection methodology.

2.2. Studied variables

The independent variable in this study was a training package focused on the application of king's science to the conservation of forest resources. The dependent variables were as follows. 1) The degree of knowledge pertaining to the application of king's science in the conservation of forest resources. 2) The extent of attitudes regarding the application of king's science to forest resource conservation.

2.3. Research instrument

2.3.1. Knowledge disseminating tool

A five-module training package to promote the king's science on the conservation of forest resources in the areas of Nong Khu-Na Dun National Forest Reservation site in Na Kha Sub-district, Mueang District, Maha Sarakham Province.

2.3.2. Testing and evaluating tool

- A knowledge testing form: This form gauges the participants' comprehension of the application of the king's science to forest resource conservation.
- An attitude testing form: This form tests the participants' satisfaction with the application of the king's science to forest resource conservation.

2.4. Data collection

The process of data collection in this study was methodically divided into three distinct steps:

- Step 1: Development of the Training Manual. This initial phase involved a thorough review of preliminary data and related scholarly research papers to inform the creation of the training manual.
- Step 2: Evaluation of the Training Manual's Effectiveness. During this stage, the focus was on assessing the manual's utility, content quality, and the appropriateness of its language and presentation.
- Step 3: Implementation of the Training Manual. This step employed a One Group Pre-test-Post-test Design to examine and compare the knowledge and attitudes of 30 community leader participants from the vicinity of the Nong Khu-Na Dun National Forest Reservation site, located in Na Kha Sub-district, Mueang District, Maha Sarakham Province. The comparison of pre-test and post-test scores was utilized to determine the levels of knowledge and attitudes of the participants regarding the training manual, which was designed to promote the application of king's science in forest resource conservation.

Table 1 shows the schedule for the training on the application of the king's science on forest resource reservation.

Table 1: Schedule for the training on the application of the king's science on forest resource reservation

Day	Time	Activities
Day 1	09.00 – 09.30	Registration
	09.30 – 10.00	Introduction of rules and regulations
	10.00 – 10.30	Coffee break
	10.30 – 12.00	Pre-test
	12.00 – 13.00	Lunch break
	13.00 – 13.30	Topic introduction
	13.30 – 15.30	Lecture on the processes of the application of king's science
	15.30 – 16.00	Recreational activities
	16.00 – 16.30	Summary of day 1 activities
Day 2	09.00 - 10.00	Start training activities with games and action songs
	10.00 - 10.30	Coffee break
	10.30 – 12.00	Lecturer on forest resources
	12.00 – 13.00	Lunch break
	13.00 – 15.00	Play games, lecture on forest resource conservation
	15.00 – 15.30	Coffee break
	15.30 – 16.00	Recreational activities
	16.00 – 16.30	Summary of day 2 activities

3. Results

This training program was designed to furnish participants with the necessary knowledge and attitudes for applying king's science to forest conservation. The objectives were multifaceted: to provide comprehensive knowledge and understanding, foster positive attitudes, enhance analytical thinking and synthesis skills, and facilitate the integration of existing knowledge with new concepts in forest resource conservation. Participants were also expected to gain a clear understanding of forest resource management strategies. A variety of instructional techniques were utilized, including lectures, interactive question-and-answer sessions, group discussions, and engaging recreational activities.

As indicated in Table 2, the efficiency of the training process (E1) was calculated at 85.42%, while the product efficiency (E2) stood at 81.80%. Consequently, the training manual dedicated to the application of King's Science in forest conservation achieved an efficiency rating of 85.42/81.80, successfully meeting the established criteria.

As delineated in Table 3, the effectiveness index of the training manual, focusing on the application of king's science to forest resource conservation, is quantified at 0.6623. This metric signifies that subsequent to the training, there was a 66.23 percent enhancement in the trainees' knowledge regarding the application of king's science to forest conservation.

Table 2: Results of the training manual assessment based on the set criteria of 80/80 criteria (E1/E2)

Training manual promoting king's science on forest resource conservation	Total score	$\bar{x}$	S.D.	Percentage
Process efficiency (E1)	24	20.50	1.80	85.42
Product efficiency (E2)	24	19.63	1.65	81.80
Teaching plan's efficiency (E1/E2)=85.42/81.82				

Table 3: Results of effectiveness index investigation of the training manual for applying the king's science to forest resource conservation

Total pre-test score	Total post-test score	Number of participants	The total score of knowledge (30×24)	Course's efficiency index
332	589	30	720	0.6623

As indicated in Table 4, the initial pre-test results showed that participants' overall knowledge regarding the application of king's science to forest conservation was assessed at an average score of 11.07, categorizing it at a moderate level. Post-training, however, this average knowledge score significantly increased to 19.63, representing the highest level of understanding. In a detailed module-based analysis, the module on 'Application Guidelines' yielded the highest average knowledge score in the pre-test ($\bar{x}$= 2.93), while the module addressing the 'meaning of king's science' registered the lowest average score ($\bar{x}$=1.80). Following the training, the module concerning 'problems in forest reservation' achieved the highest average post-training knowledge score ($\bar{x}$=4.23), whereas the module on the 'meaning of king's science' still recorded the lowest average score, albeit improved, at a mean of 3.33.

Table 4: Module-based average scores of knowledge in the pre-test and post-test

Training module	Before training			After training		
	$\bar{x}$	S.D.	level	$\bar{x}$	S.D.	Level
1. Meaning of King's science (N=4)	1.82	1.10	Moderate	3.33	0.66	Highest
2. Meaning of forest reservation (N=5)	2.223	1.17	Moderate	4.10	0.80	Highest
3. Problems on forest reservation (N=5)	2.23	1.25	Moderate	4023	0.73	Highest
4. Applying king's science on forest reservation (N=5)	1.87	1.14	Moderate	3.87	0.68	Highest
5. Application guidelines (N=5)	2.93	1.05	Moderate	4.10	0.80	Highest
Total (N=24)	11.07	4.00	Moderate	19.63	1.65	Highest

Referencing Table 5, the pre-test results revealed that the participants' average knowledge scores in applying king's science to forest conservation initially fell within a moderate range ($\bar{x}$=11.07). Subsequent to the training, there was a notable elevation in the participants' overall knowledge, which was then rated at the highest level ($\bar{x}$=19.63). A comparative analysis between the pre-test and post-test scores demonstrated a significant increase in the trainees' average knowledge scores following the training, with this improvement achieving statistical significance at the .05 level.

Table 5: Comparison of knowledge levels in pre-test and post-test scores on the application of king's science on forest reservation of the training participants using t-test (Paired samples)

Topic	Pre-test		Level of knowledge	Post-test		Level of knowledge	t	df	p
	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Knowledge of the application of king's science on forest conservation (N=24)	11.07	4.00	Moderate	19.63	1.65	Highest	-10.820	29	.000

Referring to Table 6, the analysis revealed that prior to the training, participants' average attitude score towards the application of king's science in forest conservation was 2.10, indicative of an uncertain or neutral level. Post-training, this score improved to 2.72, reflecting a general agreement or

positive attitude. A more detailed module-based analysis showed that during the pre-test phase, the module concerning 'problem and impact on forest resources' had the highest average attitude score ($\bar{x}$=2.21), while the module on 'definition of forest resource conservation' recorded the lowest score ($\bar{x}$=2.05). Following the training, the 'problem and impact on forest resources' module again achieved the highest average score for attitude ($\bar{x}$=2.89), whereas the module on the 'meaning of king's science' showed the lowest mean score ($\bar{x}$=2.54).

Table 6: Module-based comparison of attitude scores before and after the training on the application of king's science on forest reservation

Attitude on the application of king's science on forest reservation	Before training			After training		
	$\bar{x}$	S.D.	Level	$\bar{x}$	S.D.	Level
1. Meaning of king's science	2.09	0.37	Uncertain	2.54	0.51	Agree
2. Meaning of forest conservation	2.05	0.42	Uncertain	2.79	0.37	Agree
3. Problems and impacts of forest conservation	2.21	0.39	Uncertain	2.89	0.25	Agree
4. Applying king's science on forest conservation	2.06	0.37	Uncertain	2.74	0.32	Agree
5. Application guideline	2.11	0.33	Uncertain	2.64	0.39	Agree
Total (N=3)	2.10	0.16	Uncertain	2.72	0.24	Agree

As delineated in Table 7, the pre-training assessment revealed that participants' average scores regarding attitudes toward the application of king's science in forest conservation were initially categorized at an uncertain level ($\bar{x}$=2.10). Following the training, there was a notable improvement in these attitudes, with the average score advancing to the 'agree' level ($\bar{x}$=2.27). This post-training elevation in participants' attitude scores was found to be significantly higher than the scores recorded prior to the training, achieving statistical significance at the .05 level.

Table 7: Comparison of attitude levels in pre-test and post-test scores on the application of king's science on forest reservation of the training participants using t-test (Paired Samples)

Topic	Before training		Level of attitude	After training		Level of attitude	t	df	p
	$\bar{x}$	S.D.		$\bar{x}$	S.D.				
Attitude on the application of king's science on forest conservation (N=3)	2.10	0.16	Uncertain	2.72	0.24	Agree	-11.014	29	.000

The researchers developed a training manual and implemented it with a sample group, yielding the following results:

1. The efficiency index of the training manual for water resource management in Maha Sarakham Province was 91.33/83.77, surpassing the target criterion of 80/80. The manual's product efficiency index was rated at 0.635.
2. Post-training evaluations among third-year undergraduate students showed that knowledge, attitude, and skill scores in water management were statistically higher than their pre-test counterparts, significant at the .05 level. The effectiveness index of the training manual section focusing on applying king's science to forest resource conservation was 0.6623, or 66.23%.
3. The quality of human resources is vital to organizational success. This study suggests that training in knowledge and skills can foster positive beliefs and attitudes, enhancing organizational outcomes. Effectiveness as an evaluation criterion allows for analysis of how well an alternative meets project objectives, comparing actual results with expected outcomes.
4. Thinkamchoet and Wongchantra (2018) discovered that a handbook on Natural Resources and Environmental Conservation in ASEAN for youth in Roi Et Province had an efficiency score of 90.04/83.44 and an effectiveness index of 0.6670 or 66.70%.
5. The training increased villagers' knowledge about applying King's science to forest conservation, with post-training scores significantly higher than pre-training scores at the .05 level. The training manual's effectiveness was due to appropriate knowledge dissemination techniques, including lectures, games, discussions, brainstorming, and Q&A sessions, which fostered active learning.
6. Four key elements in environmental education: environmental knowledge, the process of knowledge transfer, the target groups, and the assessment of educational outcomes.
7. Attitude scores towards applying king's science to forest conservation improved post-training, with statistical significance at the .05 level. This was attributed to the environmental education framework used in the training, promoting active participation and opinion exchange among villagers.
8. Training as a medium can lead to attitude change, as explained by Noe and Schmitt (1986), thoughts, and expressions. Wongchantra et al. (2017) observed similar improvements in attitude scores post-training, with statistical significance at the .05 level.

Overall, the training was effective in enhancing knowledge and attitudes towards environmental conservation, affirming the importance of comprehensive and engaging educational approaches.

4. Discussion

In this research, the training manual developed was evaluated using a proficiency index of 85.42/81.80. This index indicates that the average

knowledge test score during training was 85.42%, while the average score post-training was 81.80%. The training manual's product efficiency index was calculated to be 0.6623, suggesting a 66.23% increase in knowledge regarding the application of King's Science to forest resource conservation among the village participants. The training content was organized into five distinct modules: 1) the meaning of king's science, 2) the concept of forest resource conservation, 3) issues in forest conservation, 4) the application of king's science in forest conservation, and 5) guidelines for utilizing king's science in forest conservation. These modules underwent rigorous testing and were validated for their high level of content reliability, and revised based on expert feedback to enhance clarity and comprehension. The development of the training manual encompassed three critical steps: Step 1 entailed the creation of the manual, Step 2 involved determining the manual's effectiveness, and Step 3 focused on trialing the manual. This approach aligns with Panusittikorn and Prato (2001), who outlined a three-step process in manual development: 1) review of relevant research papers and documents, 2) development and expert evaluation of the manual for quality assurance, and 3) field testing of the developed manual with a sample group. Foulsham et al. (2011) proposed a similar methodology for manual creation, encompassing steps like preliminary information study, user analysis, objective setting, content scope determination, design and layout planning, experimental testing for quality improvement, revisions, and practical application with a test group for data collection. Similar results were observed in the research of Nammai and Cumrae (2017) who conducted a parallel study on the development of a training manual for water resource management in Maha Sarakham Province. Their objectives were to develop a manual with a proficiency index of 80/80, compare knowledge and attitudes related to basic water quality measurement skills, and evaluate satisfaction with the training on water resource management in Maha Sarakham Province.

Compliance with ethical standards

Conflict of interest

The author(s) declared no potential conflicts of interest with respect to the research, authorship, and/or publication of this article.

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