

A study on cultivating the application of knowledge management for vocational high school teachers of mechanical engineering

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ABSTRACT: The authors studied vocational high school teachers of mechanical engineering (ME) as examples to discuss when would be the suitable occasion to apply knowledge management and what would be the most feasible manner. The research methods incorporated the modified Delphi technique and a questionnaire survey. A total number of 650 randomly cluster-sampled vocational high school teachers of ME were recruited in the survey questionnaire with a valid return rate of 62.92%. The study found that ME teachers should apply knowledge management in order to obtain knowledge, share knowledge, apply knowledge and then create knowledge. ME teachers assumed that reading books and periodicals, plus in-service training, were the best means to acquiring knowledge. ME teachers considered networking information, reading reflections and in-service training as the most feasible methods to share knowledge. They saw counselling students, designing courses and teaching as the most important aspects to apply knowledge. Furthermore, ME teachers regarded network information, reading reflections and in-service training as the most feasible ways to create knowledge. A model for cultivating the application of knowledge management was developed.

INTRODUCTION

After humans experienced the agricultural revolution, the Industrial Revolution and the information revolution, and as a result of the development of information and communication science and technology, there now comes the era of the *knowledge-based economy* [1]. Knowledge is the sharpest weapon of the 21st Century. In his book, *Managing in a Time of Great Change*, Drucker profoundly analyses the future trends of society and argues that knowledge is the major resource for both individuals and the whole global economy [2]. Based on knowledge, this economic trend generates a great global impact. Knowledge becomes an essential factor for developing an individual's future life, the competitiveness of a company and the economic growth of a nation. The traditional economy emphasises land, equipment and human resources. On the other hand, the knowledge economy era emphasises knowledge-based economic development. The one who owns knowledge will create and possess wealth. Therefore, knowledge management is now one of the main study trends in the field of management. Integrating information management and human resource management is effective in order to foster the longevity, competitiveness and development of an organisation. Knowledge management, in a sense, could be seen as a potential method to assist an organisation's management and development. On the whole, the expression *knowledge is power* has gained worldwide recognition [3][4].

The goal of education is to cultivate professionals for the future. Schools are organisations that take knowledge as their foundation; they are the main territory for knowledge transmission and creation. Teachers are the inventors and disseminators of knowledge. Therefore, identifying how to cultivate students to become knowledgeable and fit the criteria of a professional, as required by the knowledge economy environment, is becoming an important assignment for educators nowadays.

The attitudes and professional knowledge of teachers are also a core educational issue in the knowledge economy. School teachers usually ignore the knowledge held by their colleagues. As a result, they are not able to share and apply their own professional knowledge. They are also unable to detect the knowledge that they lack or to know why they need to create new knowledge [5][6]. However, if teachers can promote the concepts of knowledge management, it will create an environment in which colleagues are willing to acquire, share and apply knowledge when necessary; this new knowledge can be generated, and benefit teaching and learning at the same time. Hence, training knowledge management practitioners should start with cultivating teachers by having them foster knowledge management abilities and to use this skill in order to learn how to gain, share, apply and create knowledge. By engaging teaching activities of this kind, teachers can also help students develop such abilities; both teachers and students gain from knowledge growth [7].

Vocational education aims at enriching professional knowledge and occupational ethics, strengthening advanced study potential, promoting career development and cultivating basic technical personnel. For decades, vocational education has played a very important role in educating and training basic technical personnel in Taiwan. Nowadays, vocational high schools are facing crises due to unclear educational policies, financial difficulties, a decreasing student population, recruitment difficulties and the retirement of many senior teachers. It is necessary to introduce knowledge management to vocational high schools so as to promote their reputation and maintain their competitiveness [8]. Cultivating vocational high school teachers' knowledge management skills is becoming an urgent matter.

Hence, this study focuses on vocational high school teachers of mechanical engineering (ME) as examples to determine when to apply knowledge management and the most feasible methods are. The development and cultivation of knowledge

management applications and media by ME teachers is also examined. If they can possess the related abilities and construct a model for the application of knowledge management, then they can extend their knowledge base, develop the uniqueness of their school and reach the educational goals. This study's results may provide vocational high schools, ME teachers and their supervisors with constructive suggestions plus references for applying knowledge management.

PURPOSES OF THE STUDY

The purposes of this study were as follows:

- Explore the timing, feasibility and contents for the application of knowledge management for vocational high school teachers of ME;
- Cultivate the most feasible media and contents of knowledge management of ME teachers at vocational high school while exploring the various timings;
- Establish a model for cultivating the application of knowledge management for ME teachers.

DESIGN OF THE STUDY

A literature review was conducted to obtain the related literature for analysis and integration in order to construct a questionnaire, including knowledge management related theories and applications. The modified Delphi technique was employed to collect panellists' opinions and comments on the questionnaire's items. The researchers then integrated these results to construct the *Questionnaire for Cultivating Knowledge Management Application for Vocational High School Teachers of ME* to explore the timing, media, most feasible methods and related information, thus establishing the learning model for applying knowledge management for ME teachers at vocational high schools.

SUBJECTS

Non-purposeful sampling was employed in this study to select four senior engineering teachers at vocational high schools, one vocational high school principal and five scholars of vocational education to construct the modified Delphi questionnaire.

The population of respondents to the survey questionnaire comprised both public and private vocational high school teachers of ME. A clustered sampling method was used to select the sample. The survey questionnaire was sent to a total of 650 full-time vocational high school teachers of ME from 161 vocational high schools nationwide. There was a total of 409 valid responses returned, which yielded a valid return rate of 62.92%.

INSTRUMENT

The modified Delphi questionnaire consisted of three parts, specifically: the research description, questionnaire instruction, and questions with four dimensions on knowledge acquisition, knowledge sharing, knowledge application and knowledge creation. The descriptive analysis, chi-squared test and percentage of modes were applied in the three rounds of the Delphi technique in the questionnaire to test for consistency. The final draft of the Delphi questionnaire was modified according to the responses and feedback from the Delphi panellists in the second and third rounds.

The *Questionnaire for Cultivating Knowledge Management Application for Vocational High School Teachers of ME* was sent to six vocational high schools in southern Taiwan with a total of 59 teachers for the pre-test. Item analysis was applied to the pre-test questionnaire to delete the low discrimination ($t < 0.05$) items. The reliability of the questionnaire was tested with a Cronbach α value of 0.94, indicating the internal consistency. Finally, a descriptive statistical analysis and ANOVA test of the SPSS 10.0 version for Windows was administered in order to analyse the valid return responses.

DATA ANALYSIS

Analysis of the Modified Delphi Technique

The items of the questionnaire were analysed by descriptive analysis, chi-squared test and percentage of modes to examine their consistency. Finally, the researchers integrated the statistical results and the results of three rounds of the modified Delphi technique to modify the questionnaire. The results of the modified Delphi technique are listed in Tables 1 to 4.

Table 1: Responses on knowledge acquisition from the Delphi panellists.

Dimension	Medium	Content
Knowledge Acquisition	Chatting	Obtain knowledge from chatting
		Contact with other engineering teachers
	Professional groups	Obtain knowledge from engineering teaching association or related professional groups
	Exhibitions and competitions	Train contestants, have them join technical competitions and obtain knowledge
		Obtain knowledge from engineering exhibitions, graduation exhibitions and presentations at other schools
		Obtain knowledge from the demonstration and presentation of new software and hardware
	Benchmarking	Obtain updates and new knowledge from pre-service teachers
		Obtain knowledge from alumni
		Obtain knowledge from others' teaching
	Advanced studies	Obtain knowledge from conferences, seminars and workshops
		Obtain knowledge from on-the-job studies or training (credited, Masters or PhD)
	Readings	Obtain knowledge from publications, books and periodicals
	Internet information	Obtain knowledge from distance learning
Obtain knowledge from the Internet, such as e-mails, search engines, teaching Web sites and online databases		

Table 2: Responses on knowledge sharing from the Delphi panellists.

Dimension	Medium	Content
Knowledge Sharing	Chatting	Share knowledge and experience from chatting with engineering teachers
		Share and discuss with school teachers
	Apprenticeship	Share knowledge through master teachers of engineering subject
		Share teaching experience through cooperative teaching with other teachers
	Exhibitions and competitions	Share knowledge and experiences with other engineering teachers through professional exhibitions
		Share knowledge and experiences with other teachers by joining nationwide competitions
	Meetings of professional groups	Share knowledge and experiences with other teachers through study groups
		Share knowledge and experiences through professional teaching seminars or departmental meetings
		Share knowledge and experiences with other teachers from other schools through professional groups or gatherings
	Advanced studies	Share knowledge through training sessions, conferences and seminars
		Share knowledge and experiences through advanced studies, such as Masters and doctoral programmes
	Internet information	Share knowledge and experiences using the Internet, e-mails, search engines, teaching Web sites and online databases
	Reflection on readings	Share personal knowledge and experiences with others through journals, diaries or logbooks
		Share knowledge and experiences with other teachers through special topic reports or reflections

Table 3: Responses on knowledge application from the Delphi panellists.

Dimension	Medium	Content
Knowledge Application	Technical competitions	Apply knowledge to guide students' technical certification
		Apply knowledge to encourage students to participate in technical competitions
	Industrial and academic collaboration	Apply knowledge to foster industrial and academic cooperation
		Apply knowledge to guide students to become interns in industry
		Apply knowledge to manage professional groups
		Apply knowledge to student's parents or people's communication
	Teaching activities	Apply knowledge to the general teaching activities of engineering subjects
		Apply knowledge to professional subject teaching activities
		Apply knowledge to guide students' special projects
		Apply knowledge to plan, design and maintain engineering intern classes or laboratories
		Apply knowledge to classroom management
	Student counselling	Apply knowledge to the counselling of classroom teachers
		Apply knowledge to students' career counselling
		Apply knowledge to students' further study counselling
		Apply knowledge to engineering teachers' research and development activities
	Research and development	Apply knowledge to personal advanced studies and development
		Apply knowledge to school administrative matters
	Administration management	Apply knowledge to the design of multimedia teaching materials
	Curriculum design	Apply knowledge to designing teaching activities and contents

Table 4: Responses on knowledge creation from the Delphi panellists.

Dimension	Medium	Content
Knowledge Creation	Benchmarking	Create innovative abilities through benchmarking
		Create new knowledge by reflecting on failures
	Readings	Create new knowledge by reflecting on readings, periodicals and reports
	Industrial and academic collaboration	Create new knowledge through industrial and academic cooperation and collaboration
		Create and innovate new knowledge through technical transfer
		Create new knowledge by providing the proper incentives
	Teaching activities	Create new knowledge through engineering teaching materials, methods and the design of teaching tools
		Create new knowledge from engineering subject teaching
		Create new abilities by engaging in engineering subject action research
		Create new knowledge by organising professional engineering R&D teams
	Advanced studies	Create new knowledge from self study
		Create new knowledge through advanced studies, such as Master's or doctoral programmes
	Brainstorming	Develop new ideas or opinions through brainstorming
Internet information	Obtain information from the Internet to generate ideas and generate new knowledge	

FEASIBILITY ANALYSIS

Knowledge Acquisition

After administering an SPSS descriptive statistical analysis, it was found that advanced studies obtained the highest mean score of 27.07 among the methods of knowledge acquisition. Reading obtained a mean score of 26.45, reaching second place, as shown in Table 5.

The statistical results show that the value of Levene did not reach the statistical significance regarding the homogeneity of variance test for confirming the assumption of homogeneity. In addition, the statistical results of ANOVA, the F value reached a statistically significant level ($p < 0.05$), indicating different strategies may influence the results of knowledge acquisition. Furthermore, the results of the Scheffé test indicate that advanced studies and reading obtained a higher effect compared to other methods for knowledge acquisition. In contrast, the medium of chatting obtained the lowest effect in this category.

According to the statistical results, applying the dimensions for knowledge acquisition tended to yield different effects ($F = 14.16$, $p < 0.01$), indicating a degree of difference between vocational high school engineering subject teachers while acquiring knowledge. That is, the effects of advanced studies and reading are higher than other methods in the category of knowledge acquisition.

Knowledge Share

The statistical results show that the methods of knowledge sharing gave various effects among vocational high school teachers of ME ($F = 5.410$, $p < 0.01$). The results show that advanced studies, reflection of reading materials and Internet information obtained higher effects than other methods concerning knowledge sharing, as shown in Table 6.

Knowledge Application

The statistical results show that the effects of knowledge application methods vary among vocational high school teachers of ME ($F = 18.426$, $p < 0.01$), as listed in Table 7. That is, vocational high school engineering teachers appear to apply knowledge differently. The results also indicate that teaching activities, curriculum design and student counselling yielded higher effects than other methods of knowledge application.

Knowledge Creation

The statistical results show that the effects of knowledge creation methods vary among vocational high school teachers of ME ($F = 16.276$, $p < 0.01$), as shown in Table 8. That is, vocational high school engineering teachers seem to create knowledge differently. The results indicate that advanced studies, reading and Internet information gave higher effects than other methods regarding knowledge creation.

Table 5: ANOVA analysis of knowledge acquisition.

Mediums		Internet Information	Readings	Advanced Studies	Benchmark	Competitions	Exhibitions and Professional Groups	Chatting	F test	
									Sig.	
Knowledge Acquisition	Mean	24.54	26.45	27.07	25.44	25.12	24.42	22.44	14.16	0.00
	SD	5.05	4.12	4.43	4.44	4.59	4.91	5.62		
	Scheffee	○	◎	◎	○	○	○	△		

◎ : Highly recommended ○ : Recommended △ : Least recommended

Table 6: ANOVA analysis of knowledge share.

Mediums		Internet Information	Readings	Reflection on Advanced Studies	Apprenticeship	Competitions	Exhibitions and Professional Groups	Meetings of Chatting	F test	
									Sig.	
Knowledge Sharing	Mean	23.05	23.26	23.52	22.55	22.60	22.19	21.17	5.41	0.00
	SD	7.19	6.82	7.01	6.45	6.73	6.85	6.77		
	Scheffee	◎	◎	◎	○	○	○	○		

◎ : Highly recommended ○ : Recommended △ : Least recommended

Table 7: ANOVA analysis of knowledge application.

Occasions		Mediums							F test	Sig.
		Student Counseling	Course Design	Teaching Activities	Research and Development	Competitions	Technical	Collaboration		
Knowledge	Mean	25.47	25.47	25.55	24.40	24.35	23.90	22.59	18.43	0.00
	SD	5.09	4.69	5.18	4.91	4.92	5.20	5.61		
Application	Scheffee	◎	◎	◎	○	○	○	△		

◎ : Highly recommended ○ : Recommended △ : Least recommended

CONCLUSIONS

There are four major occasions of cultivating knowledge management application for vocational high school teachers of ME. According to the results of the modified Delphi technique, vocational high school teachers of ME may learn to apply knowledge management through the acquisition, sharing, application and creation of knowledge as shown in Figure 1.

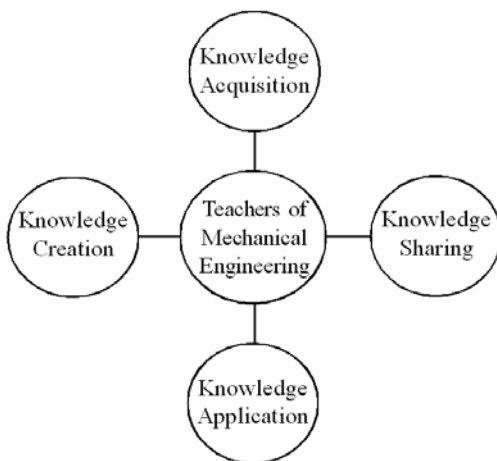


Figure 1: The four major dimensions for the application of knowledge management for vocational high school teachers of ME.

Vocational high school teachers of ME acquire their knowledge through seven major methods, including Internet information, reading, advanced studies, benchmarking, exhibitions and competitions, professional groups and chatting. Reading and advanced studies were considered to have the highest recommendation among the seven methods.

Vocational high school teachers of ME may share their knowledge with other teachers through following the seven kinds of media, including Internet information, reflection on reading materials, advanced studies, apprenticeships, exhibition attendance and competitions, professional groups and chatting. Among those media, Internet information, reflection on reading materials and advanced studies were considered to have the highest recommendation concerning knowledge sharing.

Vocational high school teachers of ME mainly apply their knowledge to seven aspects, including student counselling, curriculum design, teaching activities, research and development, technical competitions, industrial and academic collaboration, as well as administrative management. Of these areas, student counselling, curriculum design and teaching activities are considered the highly recommended. In addition, research and development, technical competitions, and industrial and academic collaboration were considered the recommended methods of knowledge application.

Table 8: ANOVA analysis of knowledge creation.

Occasions		Mediums							F test	Sig.
		Internet Information	Readings	Advanced Studies	Benchmark	Collaboration	Industrial & Academic	Teaching Activities		
Knowledge	Mean	25.19	25.32	25.46	24.46	24.47	23.86	22.48	16.28	0.00
	SD	5.41	4.83	4.96	5.80	4.85	5.31	5.42		
Creation	Scheffee	◎	◎	◎	○	○	○	△		

◎ : Highly recommended ○ : Recommended △ : Least recommended

Vocational high school teachers of ME mainly created their knowledge utilising seven methods, which included Internet information, reading, advanced studies, benchmarking, industrial and academic collaboration, teaching activities and brainstorming. Internet information, advanced studies and reading materials received the highest recommendations for creating knowledge.

The purpose of this study was to construct a model for cultivating the application of knowledge management for vocational high school teachers of ME, as shown in Figure 2. Theoretically, in order to carry out the purposes of the application of knowledge management for vocational high school teachers of ME, the contents and procedures of knowledge management should be learned in order to establish teachers' fundamental literacy and knowledge, as well as skills in knowledge management. In addition, the mechanisms and strategies should be established based on engineering teachers' recommended application timeline and media for increasing the effects and their abilities concerning the application of knowledge management. Furthermore, information technology should be used to assist and strengthen the transmission and knowledge memory abilities, as well as improve organisational culture, in order to break through the traditional barriers and thereby enhance the articulation and function of knowledge management.

SUGGESTIONS

Based on the conclusions stated above, the following research suggestions are proposed:

- The results of methods and contents of knowledge acquisition, knowledge sharing, knowledge application and knowledge creation can be provided to vocational

high school teachers of ME as reference tools to carry out knowledge management, as well as with guidelines to establish an Internet knowledge management platform;

- The model for cultivating the application of knowledge management for vocational high school teachers of ME, as developed by the authors, can be provided as a reference to vocational high school teachers to learn knowledge management and cultivate related literacy.

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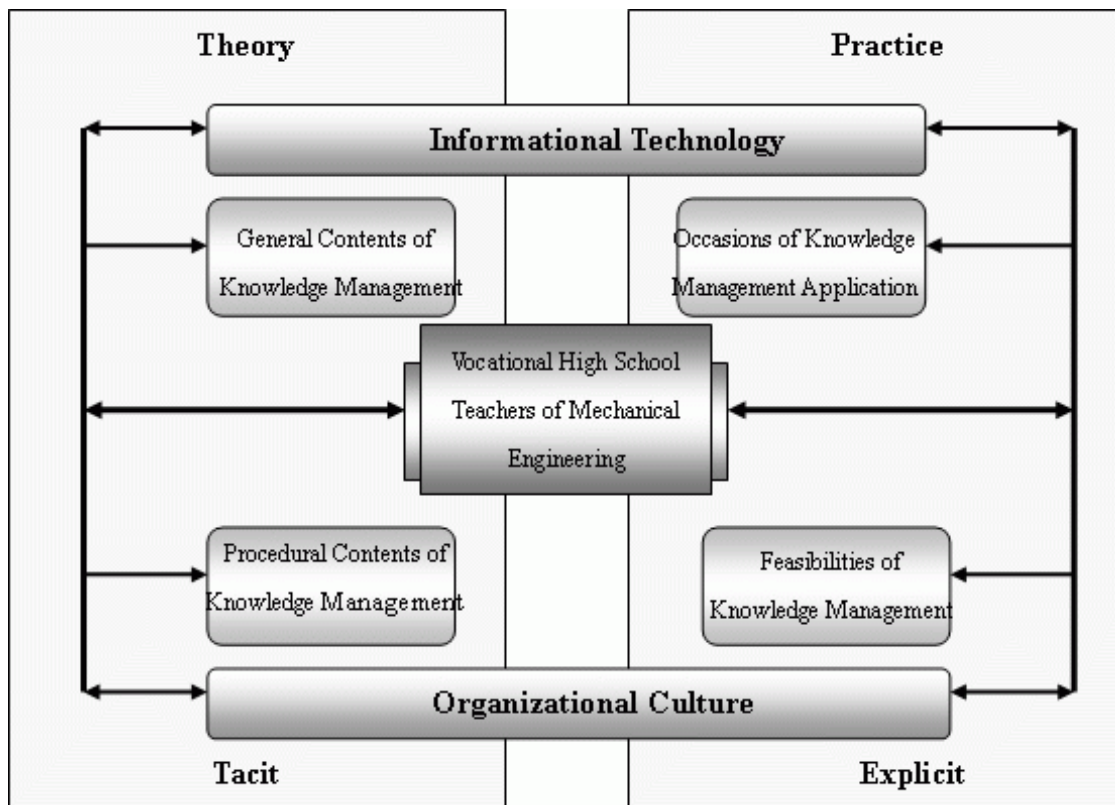


Figure 2: A model for cultivating the application of knowledge management of vocational high school teachers of ME.