

Development and preliminary evaluation of a knowledge management-based online teacher community platform for science fair instruction: A cluster analysis

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Abstract: Inquiry is the core of modern science education. In science classes, conducting science fair projects is one of the most common inquiry activities. Through conducting these projects, learners have the chance to carry out open inquiry which may help them build deeper understanding of science knowledge, concepts, science skills, and positive attitudes toward science. However, previous research has revealed that teachers encountered many challenges when implementing inquiry-based instruction, such as insufficient time, sources, professional knowledge and experience of inquiry learning. To address the important issue, by integrating community-based knowledge management (KM) tools and personal-based knowledge management (PKM) tools, a KM-based online teacher community platform was developed and preliminarily evaluated in this study. Moreover, cluster analysis was also conducted to categorize the participants' attitude-behavior patterns into different clusters, and the attitudes and behaviors of these different clusters were further analyzed. A total of 103 volunteer Taiwanese elementary school science teachers participated the system evaluations of the Teacher Science Fair Instruction Knowledge Management System (TSFI-KMS) in this study. Their responses on the quantitative questionnaire designed for the system evaluation in this study showed that they expressed satisfactory perceived usefulness and ease of use of the TSFI-KMS. Also, they expressed high willingness to use the TSFI-KMS for professional development regarding inquiry-based instruction. Further analysis indicate that the teachers' perception and usage preference toward TSFI-KMS might be influenced by their academic background and experience of using social media. In this study, suggestions on teaching practices, improvement on the system design, and future research are also discussed.

Keywords: Inquiry; science fair; knowledge management; cluster analysis

1. Introduction

Inquiry is the core of modern science education. In science classes, conducting science fair projects is one of the most common inquiry activities. Through conducting these projects, learners have the chance to carry out open inquiry which may help them build deeper understanding of science knowledge, concepts, science skills, and positive attitudes toward science. However, the literature revealed that many teachers may lack professional knowledge, time, resources, and assistance when conducting science fair instruction (Anderson, 2002), and only a few science teachers know how to guide students to conduct such projects or inquiry activities effectively (Justi & Gilbert, 2002). Therefore, supporting science teachers to develop their pedagogical content knowledge (PCK) (i.e., professional knowledge) regarding science fair instruction, as well as providing them with resources and assistance for science fair instruction, is crucial.

To address the important issue mentioned above, online communities, which have been advocated as a potential tool for teachers to promote their professional development, would be helpful. However, an online platform for teacher communities focusing on science fair instruction is still not yet available. Therefore, this study aimed to develop such a platform. Moreover, the management of professional knowledge created by an online community is always an important issue for both the online community and its members. However, most online teacher community platforms are not formulated based on knowledge management perspectives. By integrating community-based knowledge management (KM) tools (Spector, 2002) and personal-based knowledge management (PKM) tools (Tsui, 2002), a KM-based online teacher community platform was developed and preliminarily evaluated in this study. Moreover, cluster analysis (Hou et al., 2011) was also conducted to categorize the participants' attitude-behavior patterns into different clusters, and the attitudes and behaviors of these different clusters were further analyzed.

2. System development

In this study, the Teacher Science Fair Instruction Knowledge Management System (TSFI-KMS) was developed based on the KM and PKM theoretical framework proposed by Spector (2002) and Tsui (2002). TSFI-KMS is an online knowledge management environment. To meet different teachers' preferences for using the KM system, there are two different portals in TSFI-KMS: the "personal-based portal" and the "community-based portal."

The system framework of TSFI-KMS consists of several main KM and PKM modules and a knowledge base which stores members' profiles, knowledge sharing process and knowledge documents. Examples of detailed functions of the modules are shown in Table 1.

Table 1: Portals, knowledge management tool phase, modules, and functions of TSFI-KMS

Portal	Knowledge management tool phase	Module	Function examples
KM-based (community-based portal)	Communication	Communication module	Asynchronous communication tools, project progress reports
	Coordination	Coordination module	Project calendar, coordination tools
	Collaboration	Collaboration module	Images, videos, and document sharing, science fair project collaboration
PKM-based (personal-based portal)	Indexing and information capturing/management	Searching and Information capturing module	Information Indexing, Searching results combination, information capturing, information alert, information/documents uploading
	Personal communication management/analysis	Communication management module	E-mail management, communication message analysis
	Learning profile management	Personal profile management module	Learning process tracking, learning profile uploading

3. Methodology (System evaluation)

3.1 Participants

The participants of this study were 103 volunteer Taiwanese elementary school science teachers, including 41 male teachers and 62 female teachers. Regarding the teaching experience distribution of the participant teachers, 23 teachers (22.3%) had less than 5 years, 40 (38.9%) had between 5 and 9 years, 24 (23.3%) had between 10 and 14 years, and 16 (15.5%) had over 15 years. They also had various experience of science fair instruction and of using online social media, such as forums, Facebook, and blogs.

3.2 Evaluation procedures

When the participant teachers first logged into the TSFI-KMS platform, they were given a brief introduction to how to use the system. Then, the participant teachers' background information was collected through an online questionnaire before they started to explore the platform. The participants were asked to explore TSFI-KMS by themselves whenever they had free time during a period of two weeks. After the exploration task, the teachers were asked to evaluate TSFI-KMS by completing online questionnaires.

3.3 Instruments and data collection

In this study, an integrated system evaluation involving both attitude and behavior perspectives was conducted. With online questionnaires, this study collected the data regarding attitude evaluations:

1. *Teachers' acceptance of TSFI-KMS:*
The 6-point Likert-scale questionnaire developed in Phang et al. (2009) was modified and used in this study. The modified instrument consists of two scales: usefulness (6 items) and usability (7 items). In this study, the overall alpha reliability value of the instrument is 0.93.
2. *Teachers' perceived usefulness of the KM and PKM tools in TSFI-KMS:*
Two 6-point Likert-scale instruments consisting of 12 and 18 items for assessing teachers' perceived usefulness of the KM and PKM tools in TSFI-KMS were developed in this study. The alpha reliability values of the two instruments are 0.92 and 0.94, respectively.
3. *Teachers' perceived usefulness of TSFI-KMS for improving science fair instruction PCK:*
A 6-point Likert-scale instrument with 5 items developed in this study was used to evaluate the teachers' perceived usefulness of TSFI-KMS for improving their science fair instruction PCK.

The current study also collected data regarding the *teachers' participation in evaluating TSFI-KMS*. The teachers' participation in evaluating the two portals of TSFI-KMS was evaluated respectively by counting their number of clicks when evaluating the two portals of the system.

4. Major findings and Conclusions

4.1 Teachers' attitudes toward TSFI-KMS and participation in evaluating TSFI-KMS

Table 2 shows that the participating teachers expressed high acceptance of TSFI-KMS (mean=5.03). Also, they highly recognized the usefulness of the KM tools (mean=5.22) and PKM tools (mean=5.13) provided by TSFI-KMS, and agreed with the usefulness of TSFI-KMS for improving their science fair instruction PCK (mean=5.19). Moreover, the teachers had relatively more participation in the community-based portal evaluation (mean=14.74) than in the personal-based portal evaluation (mean=6.41), indicating that the teachers in this study might be more oriented towards using the community-based portal of TSFI-KMS.

Table 2: Teachers' attitudes toward TSFI-KMS and participation in platform evaluation

		mean	S.D.
Attitudes toward the platform	Acceptance of TSFI-KMS	5.03	0.59
	Perceived usefulness of the KM tools	5.22	0.49
	Perceived usefulness of the PKM tools	5.13	0.44
	Perceived usefulness for improving PCK	5.19	0.59
Participation in platform evaluation	Community-based portal evaluation	14.74	10.43
	Personal-based portal evaluation	6.41	6.06

4.2 Cluster analysis of the participants' attitude-behavior patterns

A cluster analysis using the attitude and behavior indicators (as revealed in Table 1) was further conducted in this study. We first conducted a hierarchical cluster analysis, then a Ward method's dendrogram to determine the appropriate number of clusters. The teachers' attitude-behavior patterns are divided into three clusters, as shown in Table 3.

According to Table 3, among the three teacher groups, the teachers in group B (about 3.9%) most actively participated in the community-based portal evaluation, while they had the lowest participation in the personal-based portal evaluation. Moreover, these teachers also expressed the most positive attitudes toward TSFI-KMS and the KM and PKM tools, indicating that they strongly recognized the usefulness of the KM and PKM tools. Consequently, they are more likely to continue to use TSFI-KMS, with an orientation towards using the community-based portal. These teachers with higher acceptance of the KM tools may more actively participate in an online community, and thus are likely to play significant roles in the social interactions within the online community. In other words, these teachers are usually the leaders of knowledge sharing or the mediums of knowledge exchange within online communities. Therefore, meeting these teachers' needs in improving their PCK is crucial for promoting the depth of knowledge sharing within TSFI-KMS. To this end, refinements to TSFI-KMS should be made in future research.

Table 3: The result of the cluster analysis

Attitude and behavior indicators	Clusters		
	A (n=64, 62.1%)	B (n=4, 3.9%)	C (n=35, 34%)
Acceptance of TSFI-KMS	5.01	5.23	5.06
Perceived usefulness of the KM tools	5.14	5.42	5.34
Perceived usefulness of the PKM tools	5.10	5.30	5.16
Perceived usefulness for improving PCK	5.12	5.10	5.32
Community-based portal evaluation	9.14	52.25	20.69
Personal-based portal evaluation	5.38	3.75	8.60

The teachers in group C (34%) most keenly participated in the personal-based portal evaluation, and also expressed the most positive perceptions of the usefulness of TSFI-KMS for improving their science fair instruction PCK. It seems that these teachers recognize the usefulness of TSFI-KMS for improving their PCK. Thus, they might also be willing to use TSFI-KMS in the future, with an orientation towards using the personal-based portal. Moreover, compared with most of the teachers in this study (i.e., Cluster A), they perceived higher usefulness and technology

acceptance based on TSFI-KMS. However, they had relatively lower participation in the community-based portal, which might restrain the interaction and knowledge sharing with other teachers. Therefore, how to integrate the community-based and personal-based portals more effectively should also be an important issue in the refinement of TSFI-KMS in future studies.

Although the teachers in group A (62.1%), in general, had relatively lower average scores on the attitude indicators compared with the other two groups, their average scores for these indicators were still greater than 5, revealing that they still expressed positive attitudes toward TSFI-KMS. Nevertheless, they had relatively lower average scores for participation in the platform evaluation (i.e., the mean score of the community-based portal evaluation plus the mean score of the personal-based portal evaluation), indicating that they might not be as eager as the teachers in the other two groups to use TSFI-KMS. Besides, compared with the personal-based portal evaluation, the teachers in group A were likely to be more oriented towards using the community-based portal. Since the main objective of TSFI-KMS is to improve teachers' professional development in PCK, suitable scaffolding tools provided by the platform for motivating science teachers' online professional development should be addressed in future research.

In conclusion, the teachers in this study expressed high satisfaction with and acceptance of TSFI-KMS, and scored highly on the usefulness of the KM and PKM tools in TSFI-KMS, and the usefulness of TSFI-KMS for improving science fair instruction PCK. Therefore, the TSFI-KMS platform is suitable for teachers' professional development in science fair instruction. Besides, the cluster analysis in this study revealed that the teachers in the different clusters had their own preferences and attitudes toward the use of KM tools, providing implications for platform refinements, the formation and the management of online teacher communities, and teacher continuing professional development.

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