Design and Evaluation of a Teaching-Related Knowledge Sharing System to Meet the Needs of Computer Science Instructors

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***Abstract*— This full research paper focuses on the design of a Teaching Practices Management System (TPMS) which supports the sharing of teaching practices (TPs) amongst computer science instructors. Many years of valuable TPs can be lost due to academic retirement when no competent knowledge management system is available for recording these TPs. Consequently, novice teachers are currently facing critical challenges when delivering subject knowledge that relates to algorithms, programming and the development of computational thinking skills without the benefit of others' experience. After a study of the relevant literature, it could be seen that far too little attention has been paid to the capturing and sharing of TPs which are not easily expressed or communicated in visual or verbal terms. Thus, we design and then demonstrate a Teaching Practices Management System (TPMS) which supports the capturing of TPs. A quantitative and a qualitative evaluation of users' experiences of employing the system shows that instructors are satisfied with it and are mostly positive about its features. The findings of this study hold considerable promise in relation to developing engaging and effective knowledge sharing systems for use by academic instructors.**

Keywords*— knowledge management system, knowledge sharing, higher education institutions, instructors, teaching practices, design science research

I. INTRODUCTION

Over the last decade, a growing body of research has focused on the possibilities and advantages of implementing knowledge management processes in universities [1, 2]. Reference [3] argues that higher education is an integral part of knowledge businesses because higher education institutions (HEIs) are engaged in significant levels of knowledge production, generated by academics, and it is very necessary to manage this knowledge efficiently. Teaching practices accumulated over many years of teaching and representing the experience of computer science instructors includes both know-what and know-how about the teaching of particular topics. "Know-what" knowledge refers to knowledge about the subject which must be passed on to students. On the other hand, "know-how" knowledge is not transferred to students but includes the strategies and expertise via which to deliver subject knowledge: e.g., pedagogical techniques and best teaching practices. Tremendous amounts of know-how knowledge are included in the teaching practices created by teachers. However, often, knowledge is not efficiently captured or exchanged with other teachers who teach the same courses [4]. Without the recording of TPs, academics are forced to continuously reinvent teaching practices; this leads to a situation in which there is no way to boost skills and expertise [4].

Hence, the main goal of this study is to develop a system, a "TPMS" which can act as an effective means of intervention - for supporting and motivating computer science instructors in sharing their TPs with others. The specific research question involved here is: How does using a TPMS for sharing teaching practices affect academics' perceived experience of recording and applying such practices?

II. BACKGROUND

Because of the pace of technological advancement, computer science education has become a rapidly developing field that requires instructors to keep up to date with the latest curriculum developments [5]. Due in part to these curriculum changes, teachers, particularly novices, face a range of challenges when introducing computing subject knowledge that relates to algorithms, programming, and the development of computational thinking skills [5]. Instructors are concerned with the depth and breadth of their computer science knowledge; competence in the subject, of course, allows them to feel confident about their subject matter. Reference [6] reported that instructors struggle in delivering content knowledge related to programming because it is hard to teach and hard to learn; this result in them spending hours of their time trying to improve their teaching skills in this regard. In addition, a lack of industrial experience and formal qualifications often negatively influenced the delivery of practical computer science topics [5]. Another concern was that computer science instructors had no access to some resources, such as past exam papers, that would be useful for creating activities and exams [6]. University-based computer science instructors often find it difficult to acquire knowledge concerning new computer science topics since they usually work under pressing time constraints and their day-to-day tasks are generally demand-driven; thus, they struggle to find adequate time to spend on their own continuing professional development.

Sharing teaching experiences is therefore a vital practice that can help instructors boost their teaching performance and overcome challenges. If know-how knowledge is recorded, organized, and shared so that new teachers can reuse it to support their best practices and improve their overall teaching quality, it becomes far more useful. The survey carried out in 1988 by the National Education Association survey asked teachers to assess the efficacy of various sources of teaching knowledge and skills. The study found that collaboration and communication with other teachers were most likely to be considered "definitely effective" in this regard, followed by direct experience [7].

Many scholars have identified the potential benefits of sharing TPs. They have noted that managing such teaching experience is effective for, amongst other things, promoting access to published knowledge sources within the academic community, improving overall teaching quality, facilitating the professional development activities of academics, and helping to spread best practice and so alleviate workloads [3, 8]. Without exchanging teaching practices, academics will continue to reinvent practices repeatedly – the result of a situation whereby there is no way to leverage experience and expertise [4].

To date, the pedagogical technologies available have not supported the exchange of TPs by instructors. For example, e-learning systems are focused on transmitting course content to learners [9]. Very little attention has been given by the designers of such systems to the sharing of instructors' expertise to other instructors. Moreover, the relevant tools and technologies available usually address only technical issues without taking into account end-user requirements. An analysis of the relevant literature has shown that despite the growing number of knowledge management systems developed for various contexts and purposes, few have achieved their goals in practice.

While recording teaching practices may bring many benefits, there is a risk that universities, in particular, will struggle in terms of the sharing of these [7]. The current knowledge sharing approaches utilized in universities require teachers to spend an unnecessarily large amount of time and effort when they attempt to record, retrieve, and/or reuse teaching practices. TPs are not always easily articulated or conveyed in either visual or verbal terms; they can be subjective and context-specific.

Hence, in order to resolve the above issues, it is essential to create and provide an appropriate technical environment whereby instructors can create, transfer, share and then apply knowledge effectively [10]. An information management system should ensure that instructors are not exposed to even more undue pressure because of the additional task of having to share teaching practices. Such a system must, therefore, be easy to use and should motivate its users to use it on a continuous basis [11].

III. Tool Overview

We propose a Teaching Practices Management System, "TPMS". TPMS is a collaborative web-based system which is designed to facilitate communication among academic staff, allowing them to record, store, retrieve, and evaluate their teaching experiences more effectively and efficiently. The process of knowledge exchange through TPMS involves instructors contributing content to populate the TPMS and also instructors seeking knowledge from TPMS for reuse. The concept of TPMS was derived from a framework proposed by the first author [6].

In this section, we will present the main functionality of the tool. Fig 1 illustrates the technical requirements of the system.

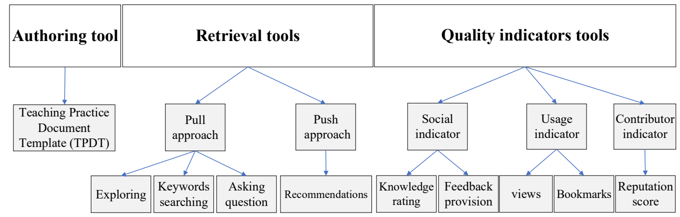

Fig. 1. Technical requirements of TPMS

A. Authoring tool

The Teaching Practice Document Template (TPDT) is a tool that assists instructors in publishing up-to-date and useful TPs, quickly, and in a way which can be clearly understood and reused by others. Its structure is that of a set of pre-specified attribute fields which, together, act as a guide when the user is creating a record of a TP. The template which has been designed for this document assists the users in describing various kinds of TP by controlling the type of information requested and providing a suitable structure for capturing the user's expertise. Table I illustrates the main attributes related to teaching practices and provides a detailed description of these attributes.

TABLE I. Description of attributes of TPs

Component	Attribute	Description
Knowledge Description	Title	The name of the TP as given by its creator
	Keywords	Tags describing the TP's topic
	TP type	Classification of the TP by its specific application (e.g., teaching experience, lessons learned, teaching material)
	Applies in	Where to apply TP (e.g., lecture, lab, seminar)
	Area	The specific purpose of the TP (e.g., formative assessment, summative assessment, pedagogy knowledge, content knowledge)
	Description	Textual description of the TP's content
	Outcome	The main outcomes which can be expected from applying the TP.
	Contributor	The person responsible for creating the content
Course Information	Discipline	The branch of knowledge to which the TP belongs (e.g., computer science, engineering, mathematics)
	Course name	The name of a course that includes the TP's topic
	Level of course	The study level of courses that include the TP's topic
Technical Information	Attachment	Related file/s (e.g., MS word, PowerPoint, PDF)
	Media format	Technical (data) type of the learning object (image, audio, video)
	Rights	Terms of use of the TP
	Date	Date of creation or availability of the content

B. Quality indicators

In order to evaluate the usefulness of the TPs which are posted, three quality indicators were implemented in TPMS, as shown in Fig. 2.

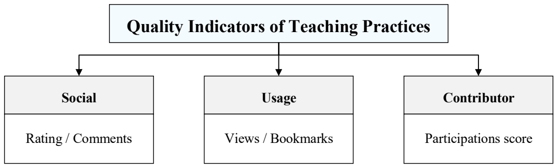

Fig. 2. Quality indicator dimensions

The social quality indicators are metrics that track the explicit feedback contributed by users, summarizing their perceptions concerning the usefulness of the TPs posted [12]. In TPMS, user ratings and comments were employed in order to allow knowledge seekers to obtain a quick overview of the usefulness and applicability of the TPs they found.

The usage quality indicators are metrics that track users' implicit feedback about other users; these are automatically acquired from user behaviours which are monitored in order to measure user's interest in, and their satisfaction level about, posted TPs [13]. In TPMS, the number of views and the number of bookmarks created in relation to a TP are taken as evidence of user interest with regard to this knowledge object [14].

The contributor quality indicators are metrics that measure the reliability and quality of content posted by knowledge contributors based on their past behaviour [15]. In TPMS, a user reputation score is employed as a contributor quality indicator [16]. Contributors with high reputation scores can be considered likely to provide the knowledge repository with high-quality knowledge items [17].

C. Retrieval technologies

Retrieval technologies are implemented within TPMS which enable the efficient customizing and refining of searches employed for retrieving required teaching practices. Two mechanisms were implemented in TPMS, as shown in Fig. 3.

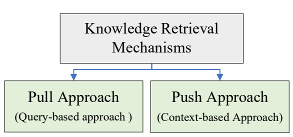

Fig. 3. Retrieval technologies

A pull approach was adopted in order to enable knowledge seekers to search for the knowledge they require, using a query-based approach [18]. Fig. 4 illustrates the knowledge retrieval facility which was implemented in the TPMS to provide a knowledge retrieval mechanism that is practical, useful, and easy to use. The retrieval process starts by enabling the formulation of a query identifying the particular keywords which should appear in the TPs description or metadata.

The querying can be carried out in three ways - exploration, search, and/or request - depending on which method is most useful to the instructor at the time.

- Exploration: An instructor searches for information outside his/her field of expertise by selecting tags or browsing the content.
- Search: A search is conducted by typing keywords into the search field. The query is processed, and the query's keywords are matched against the taxonomy used to categorize TPs. Users are also enabled to find unstructured information captured in various documents or other knowledge documentation formats by entering keywords.
- Request: Where instructors have queries that the system cannot respond to, such knowledge seekers can post a question to be answered by other experts/ instructors.

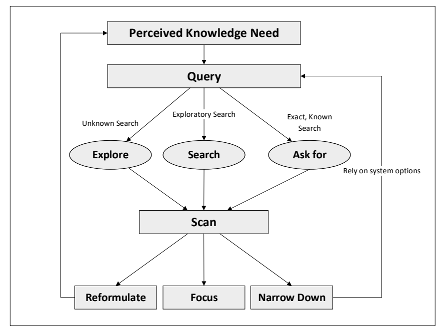

Fig. 4. Knowledge-seeking facility model

In contrast to the above, a push approach consists of disseminating newly added content to potentially interested users. TPMS adopted a context-based (recommendation) mechanism, which has access to the instructor's profile in order to determine which knowledge objects are the most appropriate to his/her preferences and needs [19].

IV. SYSTEM IMPLEMENTATION

Fig. 5 shows the components of the proposed architectural model for the system and indicates the relationships between its components. The TPMS was developed using Drupal (drupal.org), a free and open-source content management system (CMS) for creating, organizing, presenting, and managing websites [20] written in PHP.

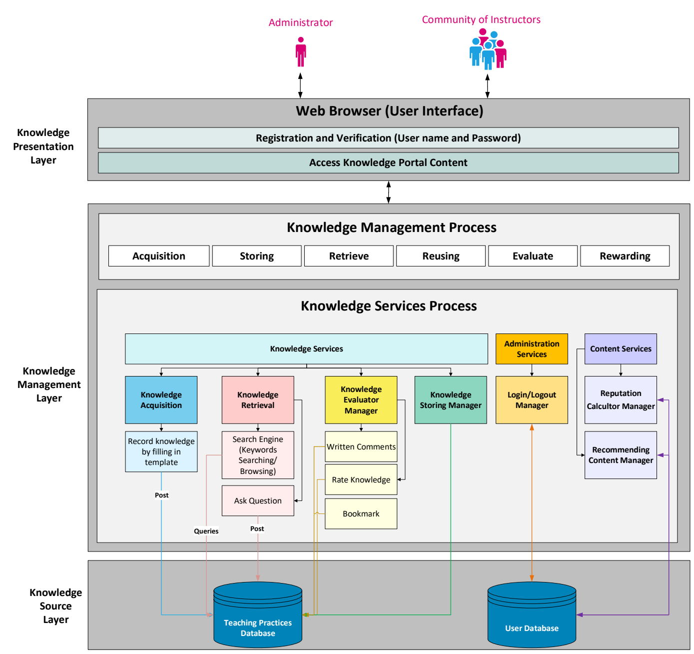

Fig. 5. TPMS Architecture

TABLE II. ACADEMICS' PERCEIVED USEFULNESS OF TPMS

Statements		Mean	Median	Std. Deviation
KC_PU1	Document Template helps me to document complete teaching practices to be understood by others than current approach.	4.60	5	0.563
KC_PU2	Document Template helps me to document my teaching practices in a consistent format with the existing vocabulary used in my university than current approach.	4.66	5	0.802
KC_PU3	Document Template helps me to document clear teaching practices to be understood by others than current approach.	4.80	5	0.406
KSt_PU1	TPMS offered safe storage for the teaching practices in one place compared to current approach.	4.13	4	0.776
KSt_PU2	TPMS repository helps me access teaching practices anytime from anywhere compared to current approach.	4.53	5	0.571
KRet_PU1	The keyword searching function helped me to reduce the time and effort required to find the teaching practices I need to perform my job than current approach.	4.47	5	0.681
KRet_PU2	The keyword browsing function helped me to reduce the time and effort required to find the teaching practices I need to perform my job than current approach.	4.67	5	0.546
KRet_PU3	The ask question function helped me to reduce the time and effort required to find the teaching practices I need to perform my job than current approach.	4.00	4	0.982
KRet_PU4	The recommendation function helped me to reduce the time and effort required to find the teaching practices I need to perform my job than current approach.	3.67	4	1.372
KE_PU1	Rating-based function enables me to evaluate the usefulness and applicability of the teaching practices than current approach.	4.53	5	0.507
KE_PU2	Written comments function enables me to evaluate the usefulness and applicability of the teaching practices than current approach.	4.50	5	0.572
KE_PU3	Reputation level function enables me to evaluate the usefulness and applicability of the teaching practices than current approach.	3.40	4	0.546
KE_PU4	Number of views function enables me to evaluate the usefulness and applicability of the teaching practices than current approach.	4.37	4	0.615
KE_PU5	Number of bookmarks function enables me to evaluate the usefulness and applicability of the teaching practices than current approach.	4.53	5	0.629

V. PRACTICAL EVALUATION: METHOD AND ANALYSIS

Evaluation is crucial in order to provide evidence that a new technology achieves the purpose for which it was designed [21]. Therefore, we conducted an experiment in order to evaluate the usefulness of TPMS for a computer science department with 30 instructors - teaching undergraduate students at Princess Nourah University in Saudi Arabia. Reference [22] defined usefulness as "the extent to which a system's functions allow users to complete a set of tasks and fulfill specific goals in a particular context of use."

The system was made available for academics to use during the first academic term of 2019/2020 (10 November 2019 | 30 December 2019). It was hypothesized that the proposed features of the system would satisfy the TP related needs of certain academics, allowing them to capture, store, retrieve, evaluate, and reuse teaching practices easily and effectively through TPMS.

A. *Quantitative Data Analysis*

We provided questionnaires at the end of the experiment. The questions included elicited demographic data plus the academics' responses to fourteen items relating to the usefulness of the system's functions, as shown in Table II. The system's functions were evaluated via the following items: knowledge capturing (KC_PU): 3, knowledge storing (KSt_PU): 2, knowledge retrieval (KRet_PU): 4, knowledge evaluation (KE_PU):5. These items all presented a 5-point Likert scale to the respondent, where: 1 = Strongly Agree, 2 = Agree, 3 = Neutral, 4 = Disagree, and 5 = Strongly Disagree.

In this study, descriptive statistics were applied: including, measures of dispersion (e.g., standard deviation), measures of central tendency (e.g., mean), and the frequency distribution for the responses to each statement in the questionnaire.

Inferential statistics were also employed [23]. The value 3, which indicates neutral and was used as the test value for the one-sample tests applied, is at the mid-point of the Likert scales used and was compared to the mean of the responses to each statement in Table II- to measure to what extent each statement was significant. Results were considered statistically significant when $p < 0.05$.

Of the 30 registered participants who took part in the experiment, 80% (n=24) were female, while only 20% (n=6) were male. The ages of the participants ranged from 25-60 years at the time of recruitment. In terms of their professional level, half of the respondents (50%) were lecturers, while a third were working as assistant teachers. The rest were professors, associate professors, and assistant professor, by percentages, 3%, 7% and 10% respectively. Participants were asked how long they had been working at their university. Half of the respondents had had 2-5 years' experience of teaching at the university, 27% had acquired 6-10 years' experience, while 17% had been involved in such work for more than 10 years. These results indicated that both male and female academics, with levels of experience ranging between novice and expert, were involved in the evaluation process; this process was intended to evaluate both contribution and retrieval types of functionalities in terms of needs and interactions, and ensure that the results obtained were accurate and comprehensive.

Table II shows that the main features of the system were generally well-received by users, with more than 90% of the participants stating that they found the various features extremely useful. The standard deviation values in this instance were between 0.406-1.372, and the mean values were between 3.400-4.800. It should be borne in mind, when interpreting this data, that any mean value larger than 3 is considered to indicate a positive evaluation. As the means for the perceived usefulness of TPMS were all greater than 3 (the neutral response), it can be inferred that the majority of the participants found that using the system's facilities was useful to them, supporting the capturing, storing, retrieving, evaluating, and reusing of teaching practices.

For example, the answers to the first three items about the usefulness of the TP Document Template, yielded mean values of 4.60, 4.66 and 4.80 respectively, indicating that the majority of academics (more than 90%) found that the structured template provided by the TPMS was useful for contributing teaching practices, enabling the complete and clear documenting of teaching practices in a consistent format using the existing vocabulary employed at the university - so that they could be easily understood by others.

The answers to the fourth and fifth items yielded a mean value of 4.13 and 4.53 respectively; this showed that the TPMS offered a safe repository for teaching practices that can be accessed anytime from anywhere and compared favourably in these respects to the current (old) approach.

Furthermore, 99% stated, via the next four items, that the keyword searching, keyword browsing, user request, and recommendation functions provided by the system enabled them to easily acquire teaching practices they needed in order to perform their job and helped them to reduce the time and effort required to find these teaching practices - compared with the current approach; the mean values here were 4.47, 4.67, 4.00, and 3.67 respectively.

Additionally, the participants agreed that the quality indicators enabled them to evaluate knowledge by obtaining an overview of the usefulness and applicability of each knowledge object. These feedback functions, the voting-based mechanism, the written feedback, the reputation level, the tallying of the number of views, and the tally of the number of bookmarks received mean 'approval ratings' of 4.53, 4.50, 3.40, 4.37, and 4.53 respectively.

Fig. 6 shows a visualization of the overall average scores for the perceived usefulness of each function in the system. In terms of which features proved the most popular with users, the majority of those questioned agreed that the TP Document Template is a useful feature that enables them to contribute comprehensible teaching practices that can be easily applied by other academics with minimum effort; this measure yielded a mean value of 4.69. The figure also shows that, even within a single knowledge sharing process, scores are not necessarily consistent across all the functions that support the process. Hence, there are specific areas of each function that might be considered targets for improvement. For example, in terms of the search functions, it can be seen that the keyword browsing was the most preferred facility among the knowledge retrieval functions with a mean value of 4.67 while the recommendation function was the least-liked feature with a mean value of 3.67.

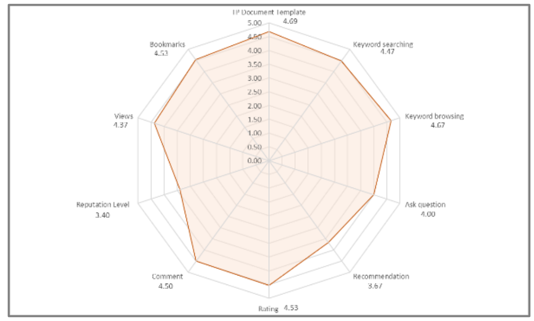

Fig. 6. Visualization of overall average scores for perceived usefulness of TPMS functions

However, the least-liked function, overall, was reputation score. As the mean of user evaluation of the reputation score feature was above 3, it cannot be considered as a disliked feature. In fact, the lower score obtained by the reputation level function could be attributable to the users' lack of understanding of the purpose of such a function. Another interpretation is that they (the users) might not have experienced any increment in their or any other instructors' reputation levels due to the short period allocated to the experiment. However, this result clearly points to the need for some kind of improvement in the reputation level function.

Broadly speaking, the above findings suggest that the academics involved in testing the system for the purposes of this study considered TPMS to be extremely useful. Thus, it is clear that most of these respondents felt positive about using TPMS for supporting the capture, retrieval, storage, and evaluation of teaching practices – more so than they did concerning the current approach.

In terms of perceived usefulness, the system and its facilities received evaluations which were statistically significant, with a p-value = .000, which of course is less than the 0.05 level of significance, illustrating the significance of the findings (mean=4.364, $t(30)= 30.239$, $P<.000$) with a 95% confidence interval (see Table III). A p-value of less than 0.05 was accepted as statistically significant, which is a standard choice of significance level. The significantly positive result indicates that participants believed the TPMS and its functions were a useful approach to supporting the sharing of teaching practices; more so than the approach currently in use.

B. *Interviews*

The semi-structured interviews were conducted at the end of the experiment with 14 participants (8 females and 6 males). The qualitative data yielded included points that were not directly addressed in the questionnaires. The aim of conducting the semi-structured interviews was to enhance the understanding of the user experience of TPMS as a technological approach to support the management of TPs. An inductive coding approach was employed to help the researcher extract themes which were mentioned by the interviewees as outlined in the next sub-sections.

1) Perceptions Concerning the use of TPMS for Knowledge Capture.

The participants were asked to express their overall opinions regarding using the TP Template to capture their teaching practices. With regard to their overall impression, most were satisfied or somewhat satisfied with the knowledge capture approach; with very few participants feeling that it did not meet their expectations and stating that the system needed more work. Table IV shows the themes which resulted from the content analysis of the interviews.

TABLE III. STATISTICAL ANALYSIS (ONE-SAMPLE T-TEST ANALYSIS)

	N	T	Mean	Sig. (2-tailed)	Std. Deviation	Std. Error Mean
Usefulness of TPMS	30	30.239	4.364	.000	.247	.0451

The academics emphasized that the template encourages them to ensure that the teaching practices are documented in a uniform and standardized way.

"The standard format makes capturing teaching practices easy and facilitates the ability to analyze and understand the knowledge content posted by others".

TABLE IV. PERCEPTION CONCERNING THE USE OF TPMS FOR KNOWLEDGE CAPTURE

Questions	Category	theme
What are the benefits of using the template for capturing teaching practices?	Template benefits	Uniformity
		Reusability
		Completeness
		Usability
		Relevant
		Effectiveness
What are the drawbacks of using the template for capturing teaching practices?	Template drawbacks	Time Consuming
		Summarization

The participants further stated that the template's attributes are relevant specifically to the context of teaching and the needs of academics in Saudi universities.

"The template's attributes are consistent with the vocabulary used in the teaching domain; this helps it to be successful in application".

Additionally, the academics agreed that the template is appropriately detailed in terms of allowing for the complete, accurate and comprehensible recording of teaching practices which may then be applied by others.

"The template's attributes help me to record a knowledge object, comprehensively, that can be read and applied easily by others".

"the structured template enabled me to really understand the teaching practice in terms of where, how and when to apply it".

Furthermore, the academics were asked how easy they found the method to use compared to the unstructured text-based approach administered by their quality assurance departments. All of them agreed that the template-based approach made it easier to capture teaching practices, as compared to the unstructured text-based approaches.

"the description of the template's attributes is exhaustive, clear and straight-forward".

These findings reflect the fact that there was a high level of acceptance and satisfaction common to all the participants involved in the interview regarding the usefulness of the system and its best teaching practice template document.

Despite the usefulness of the template function as an authoring tool for capturing teaching practices, one respondent found it difficult to summarize their teaching practices within a template, despite being enthusiastic about trying the new methodology. She said that more practice using the system would help her to structure an adequately recorded teaching practice that would be useful to other instructors.

"The negative side of the template is that someone may look at the long list of criteria or the guidelines and just say I am not going to take the time to make a submission into the system".

To overcome this drawback, a senior participant suggested that:

"it may be good to indicate which guidelines are the more critical ones, via a high priority. So, someone who has limited time to fill the template in would know that certain guidelines are mandatory, and they have to provide information in those areas when they are submitting into the database".

2) Perceptions Concerning the use of TPMS for Knowledge Retrieval

The participants were also asked to express their overall opinion about using the search functions to find and retrieve teaching practices. Generally, the feedback obtained from participants was very encouraging and supportive as the majority of participants were satisfied with the knowledge retrieval features. Table V shows the themes which resulted from the content analysis of the interviews.

The participants agreed that the easier it is for users to access knowledge sources and seek support, the greater will be the acceptance of, and motivation to use, the system

"*The system helps mitigate the time and effort needed to access experts to ask them for their expertise. I can log in the system anytime and ask a question that can be answered by many experts*".

The usefulness of the TPMS was also explicitly expressed, as the academics reported that a system which centralizes and standardizes access reduces the effort which must be made to find existing knowledge and so enhances the usefulness of existing knowledge objects.

"searching for the required teaching practices by browsing one platform is much easier than searching for knowledge by asking experts face-to-face - definitely".

The academics seemed to enjoy the simplicity of the search process employed to search for relevant knowledge, and the efficacy of this process may contribute to increasing their active usage of the system.

"I found searching for teaching experience by either typing a query or clicking on a keyword is useful. It is the simplest and the fastest way to find teaching practices".

In fact, many of those questioned were impressed with how the system tailored the knowledge displayed, based on their profile.

"I acknowledge that the system keeps me updated with the knowledge that is related to my preference".

The above results indicated that the participants were positive about the proficiency of the search tools in terms of retrieving knowledge which was sought for.

TABLE V. PERCEPTION CONCERNING THE USE OF TPMS FOR KNOWLEDGE RETRIEVAL

Questions	Category	theme
What are the benefits of using search functions for retrieving teaching practices?	Search functions benefits	Effortless
		Search Simplicity
		Accessibility
		Tailored Results
What are the drawbacks of using search functions for retrieving teaching practices?	Search functions drawbacks	Misinterpretation

However, relatively few of the participants (n=2) found that the efficacy of the knowledge retrieval functions affected the applicability of the knowledge found.

"I might need more explanation on how to apply the teaching practices in my classroom. The absence of a physical connection could lead to the misinterpretation of knowledge".

One participant suggested a solution to this problem.

"... academics can contact the expert through the information available in their profile, and then meet at the university if they need more clarification on the knowledge found."

3) Perception Concerning the use of TPMS for Knowledge Evaluation

We next asked our participants, in the course of the interviews with them, whether they heeded the feedback they received from their colleagues regarding the knowledge that they themselves posted. From a knowledge seeker's perspective, the majority of the participants' viewed the feedback mechanisms as generally quite useful. Table VI shows the themes which resulted from the content analysis of the interviews.

The participants agreed that the feedback mechanisms which had been implemented helped them to screen knowledge objects in terms of their (the objects') credibility, saved time in their knowledge search and evaluation process, and increased the likelihood that they would use the knowledge found in the system.

The participants showed a strong tendency to access, reuse and comment on knowledge objects which had acquired a high number of views, bookmarks and high average ratings from other users.

"The number of views function offers quick and straightforward feedback".

"By reading through the comments, you can better assess the usefulness and the applicability of knowledge".

"The rating mechanism enables the identification of knowledge that is rated by other users as important and up-to-date, while outdated knowledge will be rated as less important."

The academics also agreed that contributors with a high reputation level were likely to supply the system with high-quality teaching practices.

"The system is effective in providing more than one indicator for verifying and assessing the quality of knowledge."

TABLE VI. PERCEPTION CONCERNING THE USE OF TPMS FOR KNOWLEDGE EVALUATION

Questions	Category	theme
What are the benefits of using quality indicator functions for evaluating the quality of teaching practices?	quality indicator benefits	Credibility
		Save Time
		Reusability
		Motivation
What are the drawbacks of using quality indicator functions for evaluating the quality of teaching practices?	quality indicator drawbacks	Incongruous

"Browsing instructors' profiles allows you to assess knowledge credibility by checking their years of experience in teaching, courses previously taught, and activities in the system."

Hence, it can be concluded that the user feedback mechanisms are useful in helping members of professional online communities with their knowledge seeking process.

Evaluation mechanisms can be beneficial not only to members who use the system for knowledge seeking, but also to members who use the system for knowledge provision. From a knowledge contributors' perspective, the responses were interesting; all the participants reported that the quality and amount of knowledge sharing quite strongly depended on the incentive mechanism provided. They agreed that receiving feedback via others' either commenting on or rating their knowledge emerged as a positive motivation for academicians to participate in knowledge sharing activities using the system.

"Receiving timely feedback on my teaching practices means that academics are interested in my experiences. This will encourage me to add more".

"It is beneficial to get feedback from people who apply my teaching practice. This feedback gives me an insight for how my teaching practice solves others problem and makes me feel motivated to contribute more knowledge".

Although the commenting by others' generally helps the contributors to acquire new knowledge related to their contributions and so further develop these knowledge contributions; the presence of too many comments can also signal a mismatch of the participant's knowledge level and that required by the community.

"Receiving too many negative comments could make me feel detached from the community and decrease my willingness to further engage in the knowledge community".

Therefore, other mechanisms provided by the system can moderate the effects of negative comments made on knowledge contributions; these better promote continued contribution by community members.

"Being recognized is likely to lead to people being more motivated and consequently more engaged in the system".

Furthermore, the majority of the participants argued for the usefulness of the reputation level mechanism provided by the system. The reputation level function described in this study provided the participants with information regarding the number of knowledge objects generated by everyone and published in the participant's profile.

"Publishing reputation level on my public profile makes me feel honoured, I experienced some gratification as a result. It is something for me to take home".

On the other hand, some participants noted unintended side effects of the reputation status level mechanism. They mentioned that this reputation level could lead to the creation of a competitive environment which might cause some to feel pressured, controlled or observed instead of taking part in a positive activity.

VI. DISCUSSION

The empirical results reveal that documenting knowledge using the template provided by the system is effective and of sufficient value to academics that it supports the capturing of complete, clear and consistent teaching practices. The results also show that searching for knowledge using the keyword search function, keyword browsing, user request function, or the recommendation function can support knowledge seekers in finding the knowledge they require - without being impeded by social and geographical constraints. The empirical results also reveal that the feedback obtained by the system with regard to the knowledge objects is significantly associated with participants' contribution behaviour. This confirms the value of widely applied positive voting for reinforcing feelings of interest and enjoyment across online communities, thus motivating participants' continued engagement and contributions. This finding empirically confirms the general IS design principle suggested by [24], that timely and positive feedback, in the form of voting up ratings, written comments, views and bookmarks need to be provided to satisfy the user's need for acknowledgement of their competence. Gaining a positive online reputation signifies that one's contribution has been publicly acknowledged, which can increase one's sense of self-worth and self-esteem; this should lead to those who receive such acknowledgement being motivated and, consequently, more engaged in using the system. The results are consistent with [25], who found that providing a reputation level feature can increase both the helpfulness of contributions and the number of contributions, and with [26], who pointed out that reputation improvement and status-building within the community are motivation factors in relation to sharing knowledge. The findings are also consistent with the assumptions made by social exchange theory that "benefits obtained through social process are contingent upon benefits provided 'in exchange'" [27].

It can be concluded that the implementation of the design features proposed and trialled here, in online knowledge sharing communities, is likely to encourage academicians to share their knowledge and ensure that they proactively contribute to the system. The community expects knowledge seekers to eventually obtain benefits from their knowledge seeking and, therefore, be willing to repay the collective benefits they received back to the knowledge contributors by providing timely feedback on posted knowledge. This ongoing cycle creates a system of knowledge sharing that ensures the survival of an effective online professional community.

Despite the fact that [28] found that the most significant challenge to the implementation of knowledge management systems is faculty co-operation, in terms of academics contributing the results of their work to the repository, the results from the interviews showed that despite this reported negativity, in relation to the system implemented here, the faculty recognized the benefits of depositing their teaching practices to the TPMS. Most participants were satisfied with the system since they perceived the system to implement an effective approach to the sharing of their teaching practices. Reference [29] in their studies asserted that perceived usefulness had a strong and positive effect on KMS success and [30] found that user perceived usefulness in relation to KM initiatives significantly affects knowledge use. In this study, it could be seen that academicians who were satisfied with the system features were more inclined to use the system for knowledge sharing.

VII. CONCLUSION AND NEXT STEPS

The literature review highlighted the problem of ineffective knowledge sharing among higher education academics. After reviewing various knowledge management systems, it was found that none of the existing, relevant systems have been designed specifically for this context, and so these do not provide solutions that fit instructors' specific needs. To study this specific context, we developed, designed and tested our solution in direct collaboration with a Saudi university. The resultant system includes facilities whereby instructors can capture, share, retrieve and reuse teaching practices.

In this study, we contribute to theory and practice in several ways. We provide new insights into knowledge management system design and the fostering of individuals' contributions. We did so by designing and evaluating digital artefacts in a real environment. In terms of actual practice, the proposed system may well be of great assistance to higher education sector institutions. Indeed, it is believed that the system design features will become a guideline for developing systems aimed at improving teaching practice sharing among academics. It is also likely that this system design will help future developers to avoid errors and excessive costs in terms of time, effort and money. Despite the benefits the proposed TPMS could offer, actual participation and contribution of knowledge by potential users cannot be guaranteed since knowledge sharing behaviour is subject to many extraneous conditions including organizational environment and the institution's knowledge sharing policies. This suggests that it is essential for institutions to establish new policies that promote knowledge sharing behaviour, such as linking academics' knowledge sharing behaviour to annual performance assessments.

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