# Accelerating Practical Knowledge Sharing in Teachers' Communities with Human-aware Artificial Intelligence*

He Xinyi
Beijing Normal University
hxy2017110@163.com

## ABSTRACT

In the era of digital transformation, the integration of artificial intelligence (AI) technologies presents unprecedented opportunities for understanding and utilizing teachers' professional knowledge. This study explores the potential of AI-powered approaches to extract, analyze, and leverage teachers' practical knowledge shared within online professional communities. Through a series of carefully crafted research questions, we examine how advanced data mining techniques and human-aware intelligence can effectively identify, categorize, and synthesize teachers' practical knowledge from online discussions and interactions. Our research addresses three key questions: the effectiveness of AI algorithms in extracting meaningful pedagogical knowledge from online teacher communities and the development of intelligent recommendation systems that connect teachers with relevant professional knowledge. By analyzing large-scale data from teacher online communities and employing sophisticated natural language processing techniques, we aim to bridge the gap between theoretical understanding and practical application of teachers' professional knowledge. This study contributes to both the methodological advancement in researching teacher knowledge and the practical development of AI-supported professional learning communities for educators.

## Keywords

practical knowledge, online communities, teachers' professional development, human-aware artificial intelligence

## 1. INTRODUCTION

The professional development of teachers has long been a critical focus of educational research, where understanding how teachers acquire, share, and apply practical knowledge has significant implications for the quality of teaching and learning. Over the past few decades, advances in theoretical perspectives, methodological strategies, and technological tools have expanded the scope of research in this field. From analytical-rational frameworks to narrative inquiry and practice-reflection paradigms to innovative tools like online communities and artificial intelligence, research has continuously evolved to address the complexities of teachers' professional growth. However, despite these efforts, significant gaps remain in understanding how to fully leverage the collective wisdom embedded within online teacher communities and in designing effective computational systems that genuinely support knowledge sharing. These challenges drive the current investigation, which seeks to develop human-aware intelligence to accelerate practical knowledge sharing among teachers. This study is guided by three interrelated research questions. First, it seeks to unpack the core components, characteristics, and internal relationships of teachers' practical knowledge emerging in online communities (RQ1). Second, it aims to design and implement automated mechanisms that can extract this practical knowledge with contextual completeness and representativeness (RQ2). Third, building on these insights, the study explores how a human-aware artificial intelligence (AI) recommendation system can be developed to enhance teachers' collaboration and knowledge sharing (RQ3). By addressing these questions, this research contributes not only to a deeper understanding of the nature of teachers' practical knowledge but also to the design of innovative technological systems that bridge existing gaps in online community-based professional development. Accordingly, this work positions itself at the intersection of education, computational science, and artificial intelligence, offering a multidisciplinary approach to tackling one of the most pressing challenges in the field.

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## 2. RELATED WORK

After decades of evolution, international research on teacher professional development has embraced various theoretical perspectives and methodological approaches. Early studies, such as Elbaz's "three-level structure of practical knowledge", encompassing subject matter content, teaching strategies, and classroom management, introduced an "analytical-rational" orientation, focusing on the categorical deconstruction of teaching [1]. Later, Connelly and Clandinin advanced a "narrative inquiry" approach, shifting the emphasis to teachers' life histories and personal stories, promoting an "individual-experience" orientation [2]. More recently, a "practice-reflection" orientation has emerged, emphasizing the creation of knowledge through action research, collaborative reflection, and dialogical contexts. Schön's theory of 'reflective practice', for example, provides a dynamic framework to understand how teachers develop knowledge through practice [3].

On the methodological front, digital tools have played a growing role in professional development strategies. Macià and García conducted a systematic review highlighting the potential of online communities and social networks in supporting teachers [4]. Collaborative tools such as wikis, email groups, and online forums facilitate professional knowledge sharing and mutual support among teachers, but their effectiveness depends heavily on usability and alignment with teachers' training objectives. Platforms that are user-friendly and offer streamlined, clear information foster higher engagement, whereas poorly designed systems can hinder participation [4].

Although many existing models remain highly focused on individual learning design and overlook the collective wisdom of online communities, some studies have started to explore the practical knowledge embedded within these communities. For example, researchers have applied advanced data mining techniques, such as text coding, multidimensional scaling, and epistemic network analysis (ENA) to transform teacher narrative texts into actionable visual representations, including word clouds, conceptual spaces, and cognitive networks [5, 6]. Despite these advancements, current ENA and knowledge graph approaches face limitations, such as difficulty in capturing instructional contexts, inflexibility, and constraints in scalability due to small-scale, locally developed computation systems. To meet the growing needs of teacher communities, new computational architectures must be developed to enhance scalability and adaptability.

Recent contributions have started to integrate advanced technologies into teacher professional development. For example, Pishtari et al. introduced AI-powered feedback systems to help teachers align their learning designs with instructional objectives [7], while Albuquerque used clustering analyzes of more than 12,000 teaching activities to identify patterns in learning design decisions [8]. These efforts highlight methodological innovations, but have yet to fully incorporate the collaborative potential of online communities into scalable models, pointing to a critical avenue for future research.

## 3. RESEARCH QUESTIONS

In this section, we present the key research questions that guide our investigation. These research questions serve as focal points, with the aim of developing effective human-aware intelligence to accelerate practical knowledge sharing in teachers' communities. We address the following research questions (RQs) on a diverse set of educational topics, as described below.

RQ1: What are the components, characteristics, and internal relationships of teachers' practical knowledge in online communities?

RQ2: How can an automated mechanism be developed to effectively extract teachers' practical knowledge from online communities, ensuring contextual completeness and representativeness of the extracted knowledge?

RQ3: How can a human-aware artificial intelligence recommendation system be designed, based on extracted practical knowledge, to enhance teachers' knowledge sharing and collaboration?

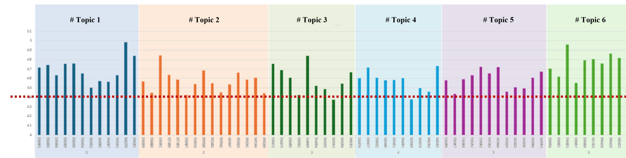


**Figure 1: The information density distribution of topics in cMOOC 9.0**

## 4. CURRENT RESEARCH PROGRESS

In this section, we discuss the current research progress made to achieve the three aforementioned research objectives.

**RQ1: What are the components, characteristics, and internal relationships of teachers' practical knowledge in online communities?**

This study took Elbaz's practical knowledge framework as its theoretical foundation and adapted and expanded it to the specific context of online teacher communities [1]. Previous studies indicated that pedagogical knowledge, contextual knowledge, and reflective knowledge were most frequently shared in online teachers' communities. In contrast, knowledge types such as educational beliefs, self-knowledge, and interpersonal knowledge, due to their highly personalized nature, were shared less frequently [4]. Given that the second research question of this study employed a data-driven approach, the analysis focused on three types of knowledge frequently shared among teachers. Importantly, these types of knowledge did not exist as isolated entities in practice but were deeply interwoven. As Carlson et al. observed, teachers naturally integrated pedagogical knowledge with reflective knowledge within specific instructional contexts [9]. Building on this inherent interconnection, this study proposed a theoretical model based on a core-periphery structure: pedagogical knowledge formed the central component, while contextual knowledge and reflective knowledge served as essential supporting attributes. For detailed interpretation, this study drew on Shulman's definition, which characterized pedagogical knowledge as knowledge related to specific topics or problems, encompassing aspects such as the design of teaching objectives and strategies to achieve these objective s[10]. Table 1 outlined the specific components of this framework.

**RQ2: How can an automated mechanism be developed to effectively extract teachers' practical knowledge from online communities, ensuring contextual completeness and representativeness of the extracted knowledge?**

To address RQ2, this study designed a joint entity–context mechanism. First, data cleaning involves retaining posts with an information density greater than 4.4 and excluding those with fewer than 20 words, as shown in Figure 1. This ensures data quality and consistency before moving on to text segmentation, resulting in a refined dataset of 3,478 posts and 181,491 words for further analysis.

Table 1: **Framework and definition of Pedagogical Content Knowledge (PCK)**

| PCK Component | Definition |
|---|---|
| Orientation towards teaching | Knowledge and beliefs about the purpose and goals of teaching a specific topic or subject |
| Knowledge of instructional strategies | Knowledge about subject- or topic-specific instructional strategies. |
| Knowledge of Context | Knowledge about contextual variables that could influence and affect the teaching and learning process, including the cohort size, time constraints, and culture dynamics. |
| Knowledge of Reflection | Knowledge formed through deep reflection and synthesis of one's practical experiences, leading to a rational understanding and improvement of teaching strategies. |

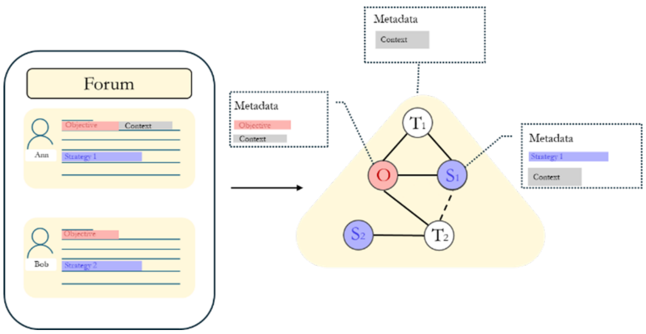


**Figure 2: Visualization of the Joint Entity-Context Extraction Mechanism**

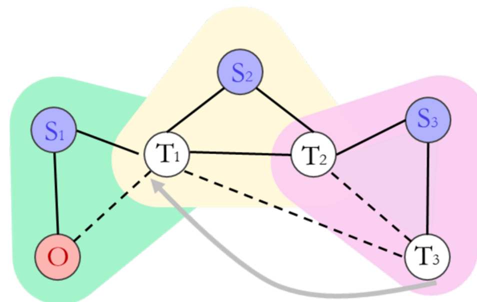


**Figure 3: the pathways of knowledge sharing**

During the data extraction process, a joint entity-context extraction framework was proposed. As shown in Figure 2, this framework comprises two essential steps: First, a basic dataset was manually annotated using the Label Studio platform. Through cross-validation evaluations, the quality of the dataset was verified and refined to ensure high standards. Second, the dataset is divided into a training set and a testing set, and the Joint Entity-Context Extraction Model is built through the following three steps:

· Select Basic Models and Integrate Embedding Module: Selected a base model capable of processing long text and supporting joint tasks (e.g., Longformer). For entity embedding, we incorporated a Conditional Random Field (CRF) layer atop the encoder to enhance the model's ability to identify entities within long text. [11]. For context embedding, incorporated a context representation layer (e.g., Pooling or Sentence-level Attention) at the encoder's summit.

·Design Joint Objective Function: Cross-entropy loss is applied to evaluate entity recognition performance. Contrastive learning loss is employed to enforce alignment between context embeddings and entity semantics. An attention mechanism is used to calculate interaction weights between entities and their context.

·Context-Entity Integration: A fusion module based on an attention mechanism is implemented to integrate contextual information with entities.

·Model Evaluation: Final models are determined through a comparative analysis of entity recognition evaluation metrics (e.g., accuracy, F1 score, AUC) and manual evaluation (e.g., random checks of critical information).

**RQ3: How can a human-aware artificial intelligence recommendation system be designed, based on extracted practical knowledge, to enhance teachers' knowledge sharing and collaboration?**

In response to RQ3 and drawing upon Sourati and Evan's research on scientific knowledge sharing algorithms [12], we developed a hypergraph model G = (V, E) to capture the complex dynamics of teacher knowledge sharing. Specifically, the heterogeneous nodes V represent:

· P (red) represents teaching objectives, such as "improving students problem-solving abilities".

· S (blue) represents different pedagogical strategies or techniques (such as formative assessment, project-based learning, etc.).

· T (white) represents teachers (such as teachers A, B, C, etc.).

The background colors represent overlapping communities, and the hyperedges are defined as forums where teachers collectively share opinions on online platforms.

Figure 2 illustrates the paths of knowledge sharing among teachers. The connections between these nodes reflect collaborative interactions among teachers, as well as accumulated teaching experiences, and the influence of peer collaboration on teaching decisions. Taking "improving students' mathematical problem-solving abilities" as an example in mathematics teaching, suppose in the figure: O represents "improving students' mathematical problem-solving abilities". $S_1$ represents "problem design based on context"; $S_2$ represents "group cooperative learning"; $S_3$ represents "mathematical modeling training"; $T_1$ is a veteran math teacher with 20 years of experience, who specializes in problem design; $T_2$ is an advocate for innovative teaching with 10 years of experience, skilled in organizing group activities; $T_3$ is a young teacher with 5 years of experience, proficient in mathematical modeling; $T_1$ excels in designing profound mathematical problems ($S_1$) but lacks experience in group teaching; $T_2$ is skilled in organizing group activities ($S_2$) but has limited knowledge of mathematical modeling; $T_3$ is adept at mathematical modeling ($S_3$) but lacks extensive experience in problem design. By random walking, it can be observed: $T_1$ and $T_2$ intersect in the yellow community and have already begun discussions about $S_1$ and $S_2$; $T_2$ and $T_3$ intersect in the pink community and explore the integration of $S_2$ and $S_3$. There is no direct connection between $T_1$ and $T_3$. The algorithm will recommend that $T_1$ establish a connection with $T_3$, as $T_3$'s skills in mathematical modeling complement $T_1$'s problem design expertise. This collaboration has the potential to produce more effective teaching strategies, thereby better achieving the goal of O. Compared to traditional methods based on popularity or simple collaborative filtering, this algorithm places greater emphasis on the community relationships among teachers, as well as the connection between their respective teaching strategies and shared teaching goals. In this way, it enables recommendations for knowledge sharing based on complementary expertise. We introduce a novel algorithm, dubbed "Bayesian-guided Random Walk" (BGRW), which seamlessly integrates Bayesian inference into the random walk framework. This algorithm is designed to adaptively adjust traversal weights in response to observed data, thereby enhancing the discovery process of teaching knowledge. Specifically, BGRW models the acquisition of teaching knowledge as a probabilistic walk on a hypergraph that we construct. Our implementation of BGRW will leverage the R package*BKT: Bayesian Knowledge Tracing* , adapting its methodologies to suit our unique requirements.

## 5. CONCLUSIONS

This research constitutes an initial effort to explore the potential of leveraging artificial intelligence and online communities to enhance teacher professional development through more effective knowledge sharing. Although our preliminary investigations have highlighted the promise of these tools, the study remains in its infancy. Critical aspects, such as the selection of appropriate AI models and the systematic comparative evaluation of their effectiveness, have yet to be thoroughly addressed. These dimensions will form a pivotal focus in the subsequent stages of the investigation.

The forthcoming doctoral consortium offers a valuable platform to refine and enhance our approach. By presenting the current progress of this study, we seek to solicit constructive feedback and insights from experts and peers in the field. Such contributions will be instrumental in guiding future developments and ensuring that the research is methodologically robust and aligned with practical needs. Through this iterative process, our objective is to develop solutions that fully support teachers in addressing complex professional challenges and to foster deeper, more meaningful collaboration within educational communities.

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