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A META-LEARNING RECOMMENDER SYSTEM FRAMEWORK FOR IDENTIFYING LEARNING PARTNER

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Abstract. *The recommendation system has been used in several business areas, one of them in the electronic learning domain. This system appeared in learning as part of learning management systems, to improve the learning process to be interactive and social. Currently, learning is not only a self-activity that can improve student competency, but learning must be a social activity that can be collaborated with others to increase knowledge and identify who are the appropriate learning partners suitable to support learning. The system needs to explore the learning partner background and expertise that fulfilled the standard of the institution. According to this situation, this study tries to identify a meta-learning recommender system framework that can help an institution to find an appropriate learning partner based on the topic of course material. This study begins with the simulation based on the learning topic of subject material. This study tries to identify what kind of expertise can be the objective of every topic of the lesson. After that, the system will search from social media LinkedIn to find out who has the expertise suitable for the requirement. In the last, the system will propose the learning partner candidate that can join the learning to enrich the learning material. The result of this study shows that the framework of meta-learning that can summarize what kind of expertise suitable per topic of learning material. Furthermore, the institution must get update what is the recent trend of jobs suitable for learning topic material.*
Keywords: Learning, Partner, Expertise, Topic, Recommender, Framework

1. **Introduction.** In recent years, the explosion of information technology has shifted the business process to be more flexible and efficient. According to this situation, users become more dependent to use technology as part of their attribute to do their activity. With the growth of technology innovation, the educational institution gets the impact. The online learning environment is becoming very popular, which can be accessed by website, mobile, tablet, another gadget platform [1]. This situation drives a student to become more active and easier to access information from many resources. Therefore, it is important to understand how a user needs to visualize the material [2].

As far as online learning is concerned, for every educational institution to increase the motivation to learn, it is important to build an attractive learning environment. A recommender system is one that can give information to recommends or suggest strategies that institutions might implement to achieve their goals. Such a system may build based on a given event, such as user trial, error systems, or user behavior observation. Recommender systems cover an important field within collaborative services that are developed in the web 2.0 environment [3]. There are many successful implementations of recommender systems that are used in the field of entertainment (movies and music), e-commerce, books,

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webpages, etc., but few are there that are used to enrich the learning environment. Only a few online learning systems have been designed using recommendation functions [4]. To design and implement an appropriate workable recommender system will be quite burdensome. Apart from a technological perspective that needs to have data about pattern combination, generate substantial server load, and the system must accommodate a critical mass user. If the institution only has small data, the recommender system becomes less accurate [5].

Recommender systems are globally shifting the landscape of the learning environment [6]. Over the decades, the recommender systems are increasingly used for suggesting music, movies, videos, products, or other items [7]. In education institution, the recommendation systems have been embedded through the Learning Management System (LMS), and to improve teaching and learning processes, it is important to have a recommender system that can analyze the learning process [8]. An LMS is an educational web-based application that can manage learning material, facilitate the student learning process, provide instructor teaching-learning material, etc. The recommender systems can improve the distribution of learning material more effectively and support the learning process. Specifically, due to the need for institutions to have a learning partner appropriate with the course material, this study tries to propose a meta-learning framework that proposes the learning partners specific to the learning topic enriching the learning process and to be more real. The learning partner could share the current trend topic and the real problem faced in the industry. In summary, the main contribution of this study is as follows: we propose a modeling of a meta-learning framework to identify learning partners based on their competency suitable for learning topics. This study also shows the metadata to address the mapping of learning partner from social media, in this study we use LinkedIn as systems that connect with a learning partner, and a modular framework to predict the learning partner expert that will be involved in the learning process, so the higher education institution can identify an appropriate learning partner to collaborate and enhance the learning process.

2. **Theoretical Background.** In many source literature, there are several propositions of the model of recommendation systems to support different areas. The main objective of recommender systems is to help the user to identify their desired items based on the user's preferences which can be read from their historical pattern [9,10]. However, choosing a suitable algorithm for a recommender system is difficult because it needs to comply with the flow or process also it must tackle information overload from many areas [11]. There are many libraries of a recommender system, but researchers and practitioners need to identify a suitable algorithm with the scenario [12].

In an educational institution, learning has been shifted from traditional classrooms into the e-learning platform. E-learning is defined as learning that utilized electronic media as a channel, principally using the Internet as the backbone of the learning environment. Educational environments involved in e-learning include learning management systems, adaptive hypermedia, forums, etc. [13].

In the academic institution, the recommender system is usually used to customize the teaching and learning process, which considers the context variables (user, content, and time). The learning-based recommendation allows learners to plan their learning process more effective, easily accessible, and convenient. Not only does the system assist the institution to identify students' problems and difficulties in learning, but it can also provide data recommendation that helps the students to find out their weakness and the system offers recommendation for improving their capacity [14]. In general, education institutions can easily find out information about their student.

Many approaches have been implemented to propose the effectiveness and efficiency of the learning process. Currently, education institutions support students with e-learning

platforms controlled by LMS, where collaboration is possible and advisable [15]. Nevertheless, collaborative learning currently is strongly growing, and recommender system can be considered as social networking tools that provide interactive and collaborative interaction, communication, and knowledge. This system can manage academic courses, where instructors manage the teaching-learning process through an integration of many aspects, such as students, digital courses, and supporting resources [8]. In collaborative learning recommender systems, the user's preferences are expressed to be analyzed that affect the system's recommendation accuracy. In general, the more pattern behavior is elicited from the user's, the more effective recommendations are [16]. This case collaborative learning strategy identifies and adopts criteria obtaining from learning partner job profile that better reflects learning partner's competency and enables to generate better recommendations to support collaborative learning between students, instructor, and learning partner using meta-learning. Several meta-learning algorithms have been implemented for predicting some tasks referring to a pattern. However, each algorithm has a bias, but can be more suitable for a particular data set from an organization [17]. In this study, the meta-learning framework will be adopted to identify the learning partner attribute profile shown in the LinkedIn account.

3. **Methodology.** Most recommender systems are focusing on the accuracy oriented to choose the learning partner. There is a need for visualization to identify a meta-learning framework that can choose an appropriate learning partner. To know how to identify a suitable learning partner, this study formulates the learning partner based on the mapping per learning topic. According to this condition, the education institution must be aware to simulate the learning topic with the job from a learning partner. The learning topic must comply with the current job description, so when the systems map the learning partner it can be suitable with the requirement. After that, the systems will generate the recommendation of learning partners that can collaborate in the class to enhance the learning process. The flow of the process to identify learning partners can be seen in Figure 1.

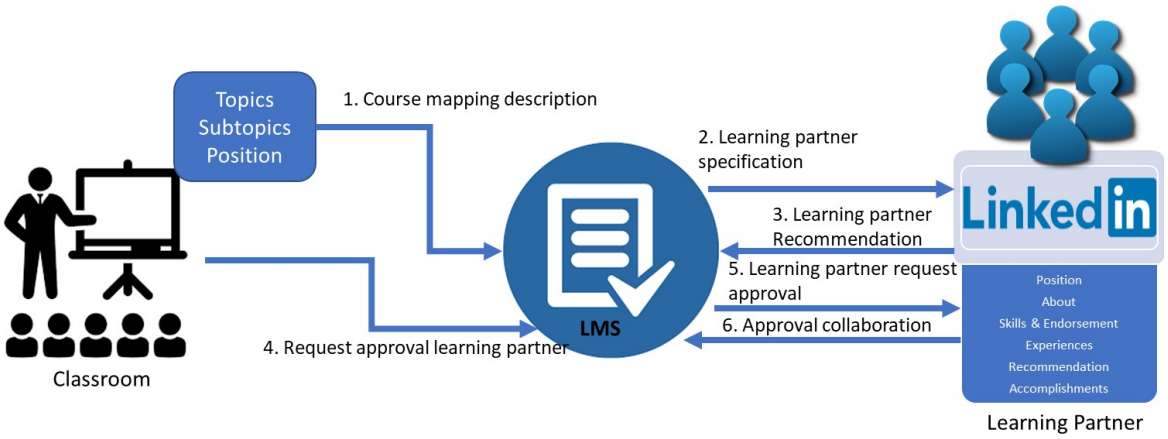

FIGURE 1. Flow event learning partner

The collaboration process between institution and learning partner begins with the institution identifying topics, subtopics, and job position appropriate according to this course. After that, LMS will connect with the LinkedIn system to define who are learning partners suitable for this course in terms of background qualification that can be defined from a position, about, skills & endorsement, experiences, recommendation, and accomplishment. Then, the LMS will show all learning partner recommendations to this course and the instructor will request approval who learning partner will be invited to collaborate

in the class. If the learning partner accepts the offering, then the learning process can be elaborated between the instructor, students, and learning partner.

In this study, we propose a new framework of a recommender system, which is divided into three main principles, which are general architecture, metamodels, and intelligent framework. For general architecture, this study presents the general architecture proposed for online learning, to integrate users and contents in the teaching and learning process to suggest the material to the students. The metamodels will describe how to integrate instructional design with a learning partner profile, and then the intelligent framework will compose the logic to implement the collaboration process between LMS and social media platforms. The framework of the learning partner recommendation system considers the three main cycles during the learning process to meet the learning objectives. The first process of creating a curriculum of academic courses that comply with the graduate competencies. The second is the mapping of a learning partner based on their competency, and the last one is the combination of the learning process to build a collaborative learning environment. These cycles are described in detail below.

- Cycle 1: Cycle 1 is carried out the creation of the curriculum academic course, that defined a strategic learning objective for a higher education institution. In the creation of the course, the material will be adding the job position mapping for every learning subtopic that will impact to pedagogical aspects in the instructional design.
- Cycle 2: In this cycle, digital resources will be generated into LMS and from the external learning resources from learning partners. The digital resource repositories contain several types of sources, such as an e-book, scientific article, case study, and video. In this section, students' profiles also will be kept because this information will be analyzed to determine student preferences.
- Cycle 3: In the last cycle we defined a learning framework for any learning customization. Particularly, the framework is adopted from the current student environment embedded with the learning partner mapping.

4. **Result.** To improve online teaching and learning strategy, the institution must have recommender systems that deeply analyze the learning variables, such as its learning method, preferences, social network, learning style, and also a recommender system that must permanently recommend the academic course, digital contents, learning partner, etc. According to these ideas, this study proposes a general framework architecture for a learning partner recommender system to be used in an online platform, which extends the concept of a knowledge-based recommender system for learning partner competency. The framework presents a recommendation model that collaborates and manages the inputs and the specific recommendation needs. The proposed framework extracts information about the context (location and connectivity), student (learning method), and course (instructional design and digital resources). This study uses sample from the database system course, which consists of six core topics for a one-semester period of learning. This course focuses on introducing database system concept and technology. From each course topic, we identified the job that appropriates with the content of learning. In Table 1, we can see the mapping of the learning topic into the job position. It means learning partners that currently have this job position or they have experience in this job position that can be involved as a learning partner for this topic.

After we do map the learning topic with a job position, we identify the meta-learning framework that can be implemented into the e-learning system. In Figure 2, it can be seen the meta-learning framework proposed for this study that involved student, instructor, and learning partner. Then, the metadata of this learning partner recommender system framework are shown in Table 2.

As seen in Figure 2, meta-learning partner recommender framework will integrate an instructional design that consists of course material and learning partner, learning partner

Table 1. Learning topics mapping

Session/ Mode	Topics	Job
1	Introduction to Databases - Points to some common uses of database systems - Characteristics of file-based systems - Problems with the file-based approach - The meaning of the term database - The meaning of the term Database Management System (DBMS)	• Database Administrator • Data Administrator • Database Specialist • Admin Database • IT Database
2	Database Environment - Three-level database architecture - Logical and physical data independence - Data models - Function of DBMS	• Database Administrator • Data Administrator • Database Specialist • Admin Database • IT Database • Database Designer • IT Database Administrator • Database and Network Administrator
3	Relational Algebra and Relational Calculus - Relational completeness - Tuple relational calculus - Relational algebra operations - Domain relational calculus	• IT Database • Database Engineering • Engineering and Technology – Database Engineer • DBA/API Developer • IT Database Engineer
4	Database Architectures and the Web - Multiuser DBMS architectures - Difference between two-tier, three-tier, and n-tier client-server architectures - Middleware - Transaction Processing Monitors - Service-Oriented Architecture (SOA)	• Database Administrator • Database Specialist • Database Designer • IT Database Administrator • Database and Network Administrator • IT Database • Database Engineering • Engineering and Technology – Database Engineer • DBA/API Developer • IT Database Engineer
5	The Relational Model - Terminology - Mathematical relations and relations - Database relations - Integrity rules - Components of relation	• Database Specialist • IT Database • Database Designer • IT Database Administrator • Database and Network Administrator
6	SQL – Data Definition - Creating tables - Data types - Integrity enhancement feature - Altering tables - Purpose of view - Creating and deleting view - Updatable views - Advantages/disadvantages of views - Access control: GRANT and REVOKE command	• Database Administrator • Database Specialist • Admin Database • IT Database • Database Designer • IT Database Administrator

mapping based on two perspectives, which are job, position, experiences, accomplishment, skills/endorsement, recommendation into a learning management system that supports learning platform. All data of each actor in this learning management system that involved instructor, learning partner, and students will be kept as meta-learning that will be combined with course detail metadata, operational learning data (schedule, forum, topic, etc.), and also with learning expert metadata generated from social media LinkedIn that extract learning partner expertise to match with the course learning material. This framework can be applied to the website or mobile learning platform.

TABLE 2. Description of variables

Context Variables	Description	Data Types
M_Student		
IDStudent	Student number	Int
Name	Student name (Full name)	Varchar (50)
Address	Student address (Street, city, country)	Varchar (100)
Majors	Student majors	Varchar (100)
SCU	System credit unit	Int
M_Schedule		
IDSchedule	Schedule Identity	Int
IDStudent	Student Identity	Int
Period	Period of learning	Varchar (50)
IDCourse	Course Identity	Int
Time	Time schedule	Datetime
M_Instructor		
IDInstructor	Instructor Identity	Int
Name	Instructor name (Full name)	Varchar (50)
Address	Instructor address (Street, city, country)	Varchar (100)
Skills	Instructor skills	Varchar (100)
Experiences	Instructor experiences	Varchar (100)
M_Course		
IDCourse	Course Identity	Int
Title	Course title	Varchar (100)
CourseDescription	Course description	Varchar (100)
Teaching & Learning Strategies	Delivery method for this study	Varchar (100)
Textbooks	Textbook description (Title, author, edition, publisher, ISBN)	Varchar (100)
M_Topic		
IDTopic	Topic Identity	Int
Session	Learning Session	Int
RelatedLO	Learning Outcome	Text
TopicName	Topic Name	Varchar (100)
References	Textbook/other resources (Additional references per topic)	Text
JobPosition	Job position	Varchar (100)
IDCourse	Course Identity	Int
M_MappingLP		
IDTopic	Topic Identity	Int
IDLearningPartner	Learning partner Identity	Int
M_LearningPartner		
IDLearningPartner	Learning partner Identity	Int
Name	Learning partner name	Varchar (100)
Degree	Learning partner degree	Varchar (100)
Position	Learning partner position	Varchar (50)
Organization	Learning partner organization	Varchar (50)
M_LPExp		
IDLearningPartner	Learning partner Identity	Int
IDExp	Learning partner experiences	Text
M_LPSkills		
IDLearningPartner	Learning partner Identity	Int
IDSkill	Learning partner skill Identity	Int
M_Exp		
IDExp	Experiences Identity	Int
ExpDesc	Experience Description	Text
M_Skills		
IDSkill	Skill Identity	Int
SkillDesc	Skill Description	Varchar (100)
M_Forum		
IDForum	Forum Identity	Int
Date&Time	Date & Time	Datetime
IDCreator	Creator Identity	Int
M_Thread		
IDForum	Forum Identity	Int
IDThread	Thread Identity	Int
IDCreator	Creator Identity	Int
Date&Time	Date & Time	Datetime
ThreadDesc	Thread Description	Text
M_Response		
IDThread	Thread Identity	Int
Date&Time	Date & Time	Datetime
IDCreator	Creator Identity	Int
ResponseDesc	Response Description	Text
Feedback	Feedback	Text

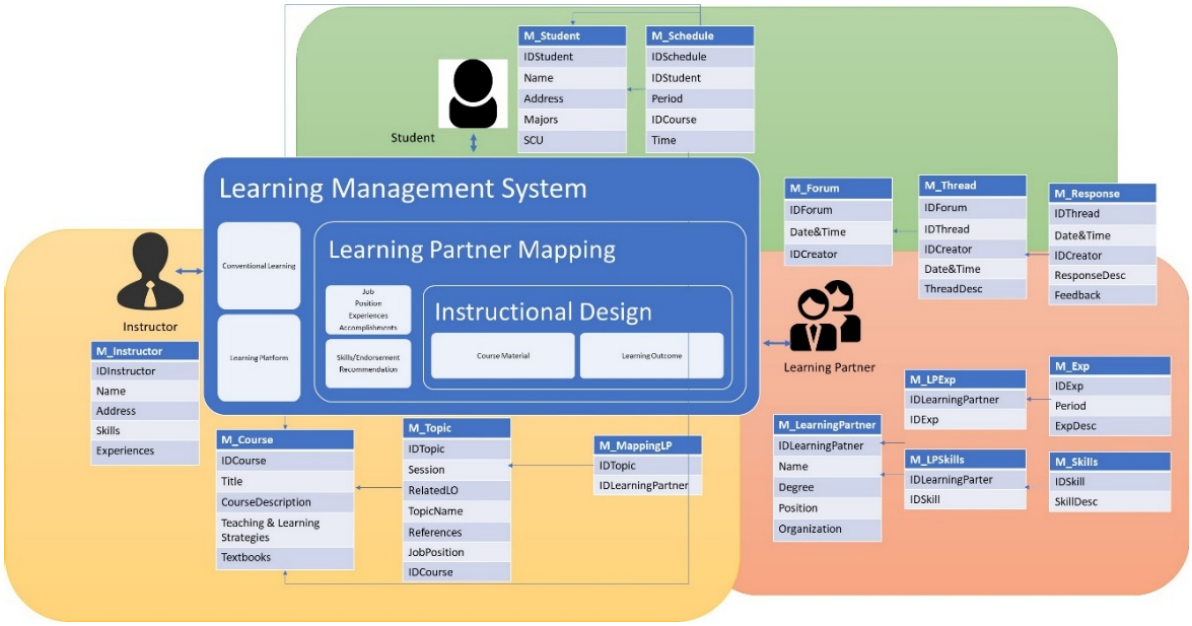

FIGURE 2. Meta-learning partner recommender framework

5. **Conclusion.** The meta-learning partner recommendation framework is proposed in this study, which can be used in any online learning platform for higher education institutions to show significance utility to give recommendations for learning partners that can collaborate with the instructor and student in the e-learning platform. The objective of this collaboration is believed that it can enrich learning material with real case studies from learning partner experiences. The framework extracts information from the context of learning material, students, learning platform, instructor, etc. Another aspect very interesting of this framework is its ability to use different learning partner information, which allows it to carry out a suggestion for learning topics. It uses position, about, skills & endorsement, experiences, and accomplishments from the LinkedIn account.

Further, this study suggests institutions must define the mapping of a job for every learning topic of their course. This study can be particularly beneficial if the education institution already has integrated learning management systems that accommodate the learning process between students and instructors. With this system, it can accommodate the conducive learning environment, which collaborates with learning partner suitable with the current learning topic material, so the learning process can be more interactive and give more benefit for a participant of learning because they can have more insight and experiences according to a real case study that be shared by learning partner. Also, the student can be early knowing the expectation of industry for the competency of the fresh graduate, so they can prepare their knowledge and skill when the time of graduate comes. Despite the contributions, this study has a limitation that can be proposed for future research, which is that this study is only constrained by LinkedIn social media. Hence, for future research it can be explored for other professional social media, so the result can be representative of all professional profiles.

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