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CoP-Networks: Virtual Spaces for New Faculty's Professional Development in the 21st Higher Education

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***Abstract*—**The 21st century higher education and globalization challenge new faculty members to build effective professional networks and partnership with industry in order to accelerate their growth and success. This creates the need for community of practice (CoP)-oriented development approaches that focus on cognitive apprenticeship while considering individual predisposition and future career needs. This work adopts data mining, clustering analysis, and social networking technologies to present the CoP-Network as a virtual space that connects together similar career-aspiration individuals who are socially influenced to join and engage in a process for domain-related knowledge and practice acquisitions. The CoP-Network model can be integrated into higher education to extend traditional graduate and professional development programs.

***Keywords*—**Clustering analysis, community of practice, data mining, higher education, new faculty challenges, social networks, social influence, professional development.

I. Introduction

THE future of higher education is being shaped by the data revolution and the application of learning solutions that demonstrate relevance to the rapidly changing social and economic environments around the world [1]. Both national and global pressures demand higher education institutions to become a locus of attraction for globally talented educators, students and researchers for the creation and dissemination of knowledge and for seeking solutions to global problems [2]. The rise of digital technology and social media will end rote learning and faculty-designed curriculum, in favor of collaborative and networked learning that appreciates the importance of an analytical mind and creative thinking. Learners are increasingly seeking the opportunity to be part of communities of learners, educators and scholars to explore, disassemble and co-create knowledge resuscitating the Latin root of the term university ""universitas magistrorum et scholarium" (roughly translated: "a community of teachers and scholars"). However, campus-based education is morphing into a more virtual world where learners are enabled to select among multiple off-campus learning platforms for the best model compatible with their preferred learning style and where professors are more to appear remotely if not replaced completely by intelligent machines [3]. This poses more challenges for current and future academics who are positioned to use advancements in data analytics and learning technologies to deliver desired outcomes and maintain a successful career path in the Information Age, where the real game changer is the core processes of intellectual and knowledge formation and management.

The success of new faculty members usually requires more than simply good hiring decisions. Institutional leaders and established professors need to understand what new faculty need and what strategies support their growth and success. They also need to thoughtfully evaluate demographics of early career faculty, their abilities and skills, and the challenges they experience in their new role [4]. Many studies have investigated challenges and factors impacting new faculty member's success in the 21st century [5]-[12]. One of the top issues is how to build effective collegial and professional network. While most higher education professionals understand the benefits of networking for advancement opportunities, professional development, and career guidance, they lack the networking strategy to connect to social and professional groups that are relevant to their field and interests as in a CoP; where they can establish long-term mentoring relationships or cognitive apprenticeship models (i.e. when more experienced individual assists a less experienced one by way of demonstration, support, and examples). Networking strategy refers to the process of identifying and developing professional contacts and building relationships for the purpose of obtaining field-specific career advice. The contemporary social networks have emerged as powerful networking platforms that enhance connectedness, social learning, information sharing for knowledge development and innovation [13]-[16]. They provide new forms of collaboration and resources-access to support personal and professional development [17]-[19]. For example, Facebook at Work is one of the very new projects in this area exhibiting a potential solution for creating CoPs on a popular social network. In social networks, people develop social relationships or ties, related to their domain of interest. These ties are important for gaining access to new knowledge and learning opportunities [20]. Social network research has shown that personal social networks may help individuals to explore more entrepreneurship opportunities, improve job performance, attain higher mobility, and achieve other career-related success [21], [22]. In addition, newcomers can benefit from social networks to learn organizational and tasks knowledge;

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and to enhance their social integration [23], [24]. However, a recent study reports that a group of medical professionals who were using Facebook for their professional development made no connections with professionally-oriented groups that might be worthwhile to support their future development or to improve their professional practices. [25]. In addition, most of the participants indicated that modern social web technologies did not support their learning as they hoped; highlighting several causal factors that are mainly related to group organization mechanisms and member self-discipline. On the other hand, seldom research has tapped into the emergence and cultivation of a social structure that maximizes the network an individual navigates in support of his or her development towards new professional practices in higher education. Despite the huge investment in technology, higher education has traditionally been notorious for the inefficient use of data to inform practice and to support new faculty members to face their upcoming challenges and to continuously develop their professional capacity while building a strong university community. Moreover, the literature indicates weaknesses in the graduate programs in regards to prepare future faculty members for academic work and to address their uncertainties about perceptions of academic life and management of complex career situations.

In this article, we adopt the notions of cognitive apprenticeship, social network and CoP and their underlying mechanisms to introduce a data-driven framework to improve the performance of new faculty members and enhance their career's success opportunities. Our approach employs a set of data mining and cluster analysis methods, social network analysis, social similarity measurement functions and multidimensional data warehouse tools to propose the CoP-Network as a dedicated social network for professional development in higher education. CoP-Network is geared by prescribed career dispositions and social interests in order to reinforce social ties that support joint career vision and practices. The rest of this paper is organized as follows. Section II discusses the challenges of beginning faculty. Section III provides the background of solutions employed in our model; while Section IV presents the logic and architecture of the model. Section V discusses the opportunities and limitations. Section V concludes the paper with future outlooks.

II. Challenges Facing New Faculty in the 21st Century

A. Major Themes

The majority of literature on new faculty challenges agrees on three main themes: clarity of expectations, finding balance professionally as well as personally, and collegiality [26]. First, most of new faculty members experience dissonance between expectations and perceived reality. The conflict occurs between what they perceived as heavy responsibilities and their own scholarly ambitions and professional development [6]. The definition of faculty work is changing; and the past model of a faculty composed of members with time to teach and conduct research has been rapidly phased out since the new millennium [5]. While faculty role is expanding to include more responsibilities, new faculty is expected to be productive in multiple roles: effective teacher, active researcher and diligent actor in the professional and public community.

Accordingly in second place, new faculty struggle to find a balance between their professional tasks as well as between their professional and personal lives [6], [9], [27], [28]. Attaining balance involved juggling multiple work and personal tasks and discovering the right blend of time spent on each area, often without direct guidance on expectations. It is evident that through their first years, new faculty continues to experience difficulties balancing time for family or other personal responsibilities outside work with their career aspirations [26]. New faculty actually reported significantly more of what is called "negative spillover" (their work life negatively "spilled over" into their personal life) than did associate or full professors [29]. Several studies indicated that the issue of balancing work and family stems mainly from poor time management [7], [8]. On the other hand, the efforts to balance the demands of professional work and personal life compound new faculty stress, which influences overall dissatisfaction [27]. Murray [30] commented that losing balance might lead them to lose drive; and if that happens, colleges and universities may find that they have a "burned-out" tenured faculty member who may have lost a family as well as a career for the sake of an unsatisfying job.

Finally, new faculty miss the culture of collegiality that been indicated as a prime key for accepting, thriving, and remaining in an academic position; and as a predictor of positive performance and early career success [6], [28]. They enter the field looking to pursue their work in a community that values and encourages collaboration and within which senior colleagues serve as mentors and role models. They want to have time and opportunity to develop friendships and interact to exchange ideas about work and institution [26]. In contrast, they feel isolated due to the lack of community, insufficient support, difficulty in building relationships with senior colleagues, and the overall atmosphere of competition and politics [6], [7], [28].

Further, several studies indicated that the three major themes are overlapped and -to a certain extent- related. For example, the recent study in [7] reported a positive association between understanding of expectations and collegiality, suggesting that departments who provided clearer guidelines for new faculty success were also perceived as more supportive. They also found that having clear expectations is positively correlated with feeling personal balance. The authors investigated "location" that has been indicated as a theme in several previous studies (e.g. [5]); and found a pattern of significant correlations among collegiality, personal balance, and location. In a different research line, the study in [10] examined new faculty emotions and how these emotions are related to their response to challenges and hence their success. The results revealed that teaching-related emotions are more strongly related to collegiality and personal balance; while research-related emotions more strongly related to

professional balance. The study also suggests that new faculty should be encouraged to see the value in their teaching and feel more control of their research ventures.

Less common themes on new faculty concerns include lack support for professional development, unclear feedback on performance and progress, poor salary and benefits, inadequate infrastructure, lack of recognition, and issues emanating from gender, color, and ethic ordination.

B. Emerging Themes

The 21st century brings more challenges for new faculty due to the new demands on higher education; and the emergence of learning technologies and smart universities [31], [32]. The Information Age arguably requires higher education institutions to focus less on the basic disciplines and offer more on professional programs to deliver graduates with generalist knowledge and advanced social skills. Employers are seeking graduates who are adaptable, responsible, life-long learners and creative, and those who are also able to engage in effective and complex communication with others. This has placed an increasing emphasis on the outcomes of higher education and the evaluation of these outcomes using new data sets and indicators to demonstrate that learners have actually mastered specific knowledge and skills objectives as a result of their learning. Further, the areas of concerns in higher education nowadays lie in three main domains:

- Shaping the knowledge society by delivering graduates who can make significant decisions in complex, dynamic and risk-fraught environments. They are also expected to develop smart strategies to tackle real-time composite problems for which simple technical "know-how" alone would not be sufficient.
- Employability or market relevance to ensure a stronger link between higher education and practice, since higher education programs which are merely based on tacit or technical contents are no longer considered adequate to meet the needs of professional practice.
- Lifelong learning capacity to allow learners to acquire further qualifications or skills independently throughout their career path.

Several educational research studies and reports (e.g., NMC, EDUCAUSE) identify the emerging educational information technology trends and solutions (i.e. mobile applications, learning analytics, Internet of Things, games and gamification) to address the above concerns and enhance higher education outcomes. This raises the question: to what extent are new faculties prepared to practice in alignment with 21st century demands? The study in [26] provided a discussion of expected competencies and skills of new faculty including knowledge and skills in the core areas of faculty work (i.e. course design, teaching diverse learners, using technology to facilitate learning), professional attitudes and habits, interpersonal skills, and conceptual understanding. Eddy [11] noted that preparing new faculty members requires currency with new teaching strategies, facing students who differ from those in the past with respect to demographics and preparation, and incorporation of technology into classroom methods. Thus, the challenges in this area remain as follows:

- Market-Practice Disconnect: most of new faculty members are unable to bring real work experience to their classroom teaching. In return, they face a difficulty in establishing the link between in-class learning and practice, as well as in developing the technical or vocational orientation of their learning programs. This contributes to their failure to meet the desired outcomes of higher education programs while shifting from the "learning about" to "learning to be" model.
- Teaching-Technology Integration: Despite the expanded presence of information technology within higher education, there was no significant difference between using computing solutions to generate information and using them to construct knowledge in higher education. In contrast, there is still a sizable gap between the adoption of new technologies and truly leveraging generated data and analytical solutions to enhance outcome quality, especially in terms of teaching and learning [33], [34]. New faculty are challenged to develop teaching strategies that are different than what they were taught in the school, and to apply the emerging learning technologies to connect to learners, discover learning patterns and design course accordingly, identify any risk or opportunity within academic programs and learning settings, as well as to evaluate learning outcomes, and diagnose individual deficiencies and prescribe required improvement.
- Individual Development Planning: new faculty needs to take personal responsibility for their individual development in the digital era. This goes beyond the traditional professional development programs into becoming active members of online CoP. This new virtual structure of CoP-based professional development is perceived to overcome the challenge of networking formation in higher education institutions which are known for its fragmented structure that often create obstacles to the implementation of institutionalized socialization practices [12].

III. Background

A. Community of Practice

Elements of learning community and suited learning concept formed the basis of the development of the CoP concept in the early 1990s; when Lave and Wenger [35] suggested that most of the learning for practitioners occurs in social relationships at the workplace rather than in the classroom setting. Learning happens then as a result of information and experiences exchange that enables members to accumulate knowledge, build up their capacities and so develop themselves at personal and professional levels. The CoP concept is refined to focus on socialization and learning and the individuals' identity development. It is then defined as an entity bounded by three interrelated dimensions: joint enterprise (what it is about), mutual engagement (how it functions), and a shared repertoire (what capability it has produced) [36]. A CoP has an identity as a community from

the sense that it is about something and it shapes the identities of its members who are informally bounded by what they do. A CoP also produces a shared practice as its members engage in a collective learning process. Thus, a CoP is different from a community of interest and other group structures that do not imply a shared practice. Accordingly, there are three main characteristics distinguish a CoP from other groups [37]:

1) The domain: a domain of knowledge creates common ground (general area of interest) that motivates interested members to participate, provides directions to their learning and shapes their behaviors and actions.
2) The community: the notion of a community creates the social fabric for that learning.
3) The practice: shared resource of experience and expertise which the community develops, shares and maintains around its core of knowledge.

In this essence, CoPs are social structures that focus on knowledge and enable the management of this knowledge to be placed in the hands of people who actually use it in their activities (practitioners). Members of CoPs share their expertise and mutual understanding about the domain to build cumulative knowledge and advance the domain by bringing their practice to a new level. Thus, Wenger in [38] introduced CoPs as groups of people who share a common passion for something that they know how to do, and who interact regularly in order to learn how to do it better. Accordingly, CoP is created specifically to gain knowledge in a particular domain of interest and it is derived by the common interest of its member to evolve naturally to enhance knowledge exchange and improve the practice of interest.

As knowledge is central to formal education and professional practice, CoPs play central role in knowledge management (KM) strategies and collaborative learning as they provide the platform and mechanisms for knowledge creation, share and exchange. Apparently, knowledge sharing is different than knowledge exchange in a sense that sharing occurs in one-way transmission form while exchange occurs at dyadic level indicating a form of reciprocal relationship [39]. Knowledge is divided into two distinct entities: explicit and tacit. Explicit knowledge is the knowing about the topic by the possession of information and facts; while tacit knowledge is the knowing how that is the procedural and application form of knowledge [40]. CoPs are particularly celebrated for the creation and exchange of tacit knowledge. So, while the work on developing an effective CoP concept did not produce a new pedagogical approach, it absolutely provided an analytical view of learning and shifted the emphasis from formal learning towards suited learning that has become to be "knowing how to be in practice" rather than "knowing the practice" [41].

A virtual CoP is a CoP that is developed on and maintained using the Internet. To qualify as a virtual CoP, the characteristics of a CoP as described earlier must be met. So, a virtual CoP must include active members who are practitioners, or professionals, in a specific domain of interest. Members must actively engage in a collective learning process within their domain through social structures that assist in knowledge creation and sharing. There also should be multiple mechanisms to facilitate the long-term support as well as to enable immediate synchronous interactions.

B. Social Networks and Social Capital

Social networks are formally defined as a set of actors who are tied by one or more types of relations (e.g., friendship, partnership, etc.). The idea of "social network" has roots in psychology and sociology, where scientists investigated ways in which small community structures could influence individual perceptions and action choices [42]. Network structure was initially described by Moreno [43], who introduced the idea of representing social structure as a network diagram of points and lines, labeled as "socimetry". The individual, who can establish links or contacts with other individuals in the network, represents a "social atom" that is the smallest unit of the social structure in a community. The community in a social network system is considered to be a significant property of social network structure as it often accounts for the functionality of the whole system. As individuals interact in the social network, they create the "social capital" that refers to the advantages or resources that individual or groups enjoy because of their position in a social structure [44], [45]. The underlying metaphor is that individuals with high social capital are those who perform better because they are better connected to other actors. Certain individuals or certain groups are connected to certain others, trusting certain others, dependent on exchange with certain others, and obligated to support certain others. Holding a certain position in the structure of these interactions can be an asset on its own and that asset is the social capital, or as defined by Bourdieu in [44]: The sum of virtual and actual resources accruing to an individual or group by possessing durable network of relationships of mutual understanding and recognition. By definition, social capital involves various features of social structure, such as trust, norms, and connections which all can improve the efficiency of society or group by facilitating the coordinated actions.

C. Social Network Analysis

Social network analysis refers to the process of investigating social structures through the use of networks and graph theory. Social networks are modeled as a graph G of pair of sets $G = (V, E)$, where V is a set of n nodes (individual actors, people, or things within the network); and E is a set of edges or tiles (relationships or interactions) that connect pairs of nodes. The graph theory then provides a set of abstract concepts and methods for the analysis of graphs using graph-based measures which, in combination with other analytical tools developed specifically for the visualization and analysis of social networks, form the basis of structural analysis referred to as social network analysis (SNA) [46]. SNA, in general, focuses on the characteristics of ties connecting individuals in a network rather than on the characteristics of the individuals themselves. It views personal communities as networks of individual relations that people foster, maintain, and use in the course of their daily lives. It also evaluates how

structural regularities influence individuals' behaviors and actions. There are two main forms of SNA: the ego network analysis, and the whole network analysis. In 'ego' network analysis, the network of one individuals (ego) and his connections (alter) is studied using individual elements metrics; while in whole network analysis, SNA tries to find all relations between the participants in the network using network level metrics. In this essence, SNA facilitates: (i) identification of individuals' social circles; (ii) identification of individuals and groups playing central roles; and (iii) identification of isolated individuals and groups and information flow bottlenecks. Analysis output could be then used to detect communities within networks in order to improve and accelerate information and knowledge flows across the network; and to enhance information exchange for different purposes (e.g. learning, business, marketing) [47], [48].

D. Data Mining and Clustering Analysis

The field of DM study emerges from statistics, machine learning and database systems to attain main objectives that are categorized into classification, estimation, prediction and data description [49]. Data mining itself is not the goal but a tool used to address strategic questions and to support decision-making. Thus, data mining process is initiated by a strategic question, followed by steps to:

1) Find and collect the most appropriate data to answer that question. Collected data must be filtered for relevance and stored in a useful form.
2) Analyze the data through connecting, linking, clustering, classifying, associating and correlating different data sets to be able to grasp the information that is supposed to be conveyed by these data.
3) Visualize data where findings are represented in understandable and actionable manners; to guide the decision-making process.
4) Provide/ collect feedback and integrate findings into the existing processes of addressing the strategic problems.

As data are collected in the data warehouse and analyzed by different functional modules, the data visualization step that comes next is a graphical presentation of the data to provide a qualitative understanding of the information contents and trends in a natural and direct way [50]. A typical DM system consists of the following major components:

- Database, data warehouse, World Wide Web or other information repository.
- Database or data warehouse server: responsible of fetching data based on the user's DM request. This includes performing data pre-processing operations (e.g. cleaning and transformation).
- Knowledge base: includes the knowledge domain to guide the search or to evaluate the interestingness of resulting patterns.
- DM engine: consists of a set of functional modules to perform DM tasks (e.g. classification, prediction, association and correlation analysis, and cluster analysis).
- Pattern evaluation module: employs interestingness measures (e.g. easily understood pattern, valid, potentially useful and novel). It interacts with the DM engine and knowledge base to focus the search toward interesting patterns.
- User interface: communicates between users and the DM system allowing users to specify the DM query or tasks.

Cluster analysis is a discipline of DM that involves set of methods and algorithms to analyze multivariate data in order to discover the natural groupings of set of points, objects, or patterns according to perceived or measured intrinsic features or similarity. Merriam-Webster Online Dictionary defines cluster analysis as: "a statistical classification technique for discovering whether the individuals of a population fall into different groups by making quantitative comparisons of multiple characteristics". In operation terms, clustering can be defined as follows: given a representation of n objects, find the K groups based on a certain measure of similarity to satisfy the condition that the similarities between objects in the same each group of K are high, while the similarities between objects in different K groups are low [51]. Accordingly, a cluster is a set of objects that is compact and isolated. Clustering analysis aims to find underlying structure in data and identify salient features. Data clustering has also been used to identify the degree of similarity among organisms and as a method for organizing and summarizing the data through cluster prototypes [52].

IV. CoP-Network Cognitive Apprenticeship Model for Faculty Professional Development

A. Logical Framework

We propose a virtual cognitive apprenticeship environment synthesized by CoP and social network models to support a successful career for faculty members in the 21st century. The proposed CoP-Network environment aims at enabling faculty members to dynamically operate between their cognitive models (i.e. experiences and knowledge) and the evolved domain-specific practices and insights driven by social interactions and industry-data exploration to identify new or verify existing knowledge/practices. The ancient apprenticeship methods enable individuals to observe then repeat the practices of mentors. However, implementing CoP as online social network acts as a virtual environment, where social interactions and collective intelligence contribute to the development of individual professional skills based on initial career dispositions data and advertised professional development interests and objectives with support from career-domain expert professionals.

Thus, the experience with the CoP-Network apprenticeship process starts as individuals fill a self-report tool in order to measure initial skills, competencies and professional traits; and capture future interests and objectives in a profile we refer to as the "Professional Development Profile" or PDP. PDP is also augmented by the data captured from social networking profiles of individuals to identify social interests and activities. Profile data are then used to cluster individuals of similar professional patterns to participate on CoPs. Individuals of

similar CoPs are connected by their common social interests to build a more focused CoP-Network. Individuals in such networks can benefit from the power of social similarity and social capital towards achieving their career goals and objectives. We propose utilizing the link information available in the contemporary social networks (e.g. Facebook) to capture social similarity and establish relations that guide individuals to work together. The members' constant interactions within CoP and constructed CoP-Network create a live or a dynamic knowledge container and a repertoire of shared practices and experiences. Our dynamic CoP structure evolves to be more focused domains by forming sub-CoPs of all individuals who are interested in certain topics or problems and who may also recognize and then reach out for other potential members (outside their CoP) for multidisciplinary programs. In addition, our model suggests a new role provided by the industry that is incorporating representative professionals or industry experts to maintain market-practice relevance while providing up-to-date vocational orientation for community members to sustain their professional and pedagogical development in a collaborative effort. CoP-Networks are also linked to a learning source for emerging and key developments in educational technology for higher education in order for members to improve their digital literacy, understand technology implications for teaching and learning practice, and experience more efficient implementation of new practices and pedagogies.

The model also integrates social network analysis engine to identify the structural positions of individuals within CoP-Networks to understand and then exploit the functions of influence that mediate and lead relationships and exchanges among community members. This task seeks to identify a small set of individuals, of whom are the most influential power (referred to as a seed set); and who can ideally maximize the influence across the entire network in minimal time.

B. Model Architecture

Our proposed mode is illustrated in Fig. 1. The development of our model entails integration of a set of data-driven technological solutions to devise the following modules:

Multidimensional data warehouse module: stores a large collection of individual-oriented, time-varying, integrated and non-volatile data to support cognitive apprenticeship development. The proposed warehouse presents multidimensional logical views about apprentices. The accumulated data across a range of assessment tool deployment instances provide a rich career-related data warehouse to facilitate the analysis based on historical data. To further assist career path construction that is more tailored to individual apprentices' profile, we augment the data set with four sources. The first is retrieved from individual profiles PDFs, which are standard attributes stereotyping each faculty member. The second is derived from domain ontologies to customize development recommendations according to domain knowledge that represents industry needs/ links. The third data set is collected from social interactions of traces left by individuals within social networks and communities. Finally, the last data set captured trends and training materials on educational technologies adopted in higher education. Thus, the data warehouse system is equipped by data pre-processing operations (i.e. extract, transform and aggregation) in order to support collection of different types of data from multiple sources, and transforms them into a common, multidimensional data model for efficient querying and analysis.

Clustering analysis module: incorporates clustering algorithm as a data mining method that uses stored data about individuals to assign them into common virtual CoPs according to their career interests and professional development needs. The clustering algorithm applies a fuzzy-logic objective function to consider the natural overlap nature of industrial needs and career paths by allowing cluster overlap, i.e. each individual to be in more than one cluster or CoP.

Social similarity matching module: constructs a CoP-Network by calculating social similarity measures across individuals' profiles and establishing links between individuals with highest similarity. The module employs the Euclidean distance function that is the basis of many distance/ similarity functions used for matching user profiles in a network [53], [54]. Euclidean distance is mostly appropriate for data measured on the same scale and thus it is most often used to compare profiles with a set of responded variables or attributes. For example, consider profiling data consists of career interests or social hobbies information for a sample of individuals, arranged as a respondent-by-variable matrix. Each row of the matrix is a vector of n numbers, where n is the number of variables. A common similarity (or distance) is evaluated between any pair of rows to reflect similar career aspirations or social activities.

Social analytics engine: investigates networking process, roles, properties of ties, relationships and how individuals develop and maintain these relationships towards supporting their professional development. This module also incorporates structural influence diffusion techniques to select seed nodes effectively in order to maximize influence diffusion and positive behavioral changes in CoP-Network.

Social influence management module: identifies the seed groups (most influential individuals or key users) with special personal abilities, who also are eligible to increase diffusion of desired career behaviors across the social network. The features of a successful influence model involve the prominent role of a higher recruiting authority (or industry representative) that facilitates positive interactions between key users and market environments about career prospects.

Visual user interface: presents CoP and CoP-Network participation and networking activities and recommendations for users along with an overview of their analytical results to reflect on and provide feedback for future consideration. It includes a dashboard view to provide links to up-to-date industry trends and job market needs for future planning. Thus, individuals will be able to use their mobile, iPad and

laptops to interact with the system, while working on their career capacity with clear visualizations and prompt feedback and recommendations.

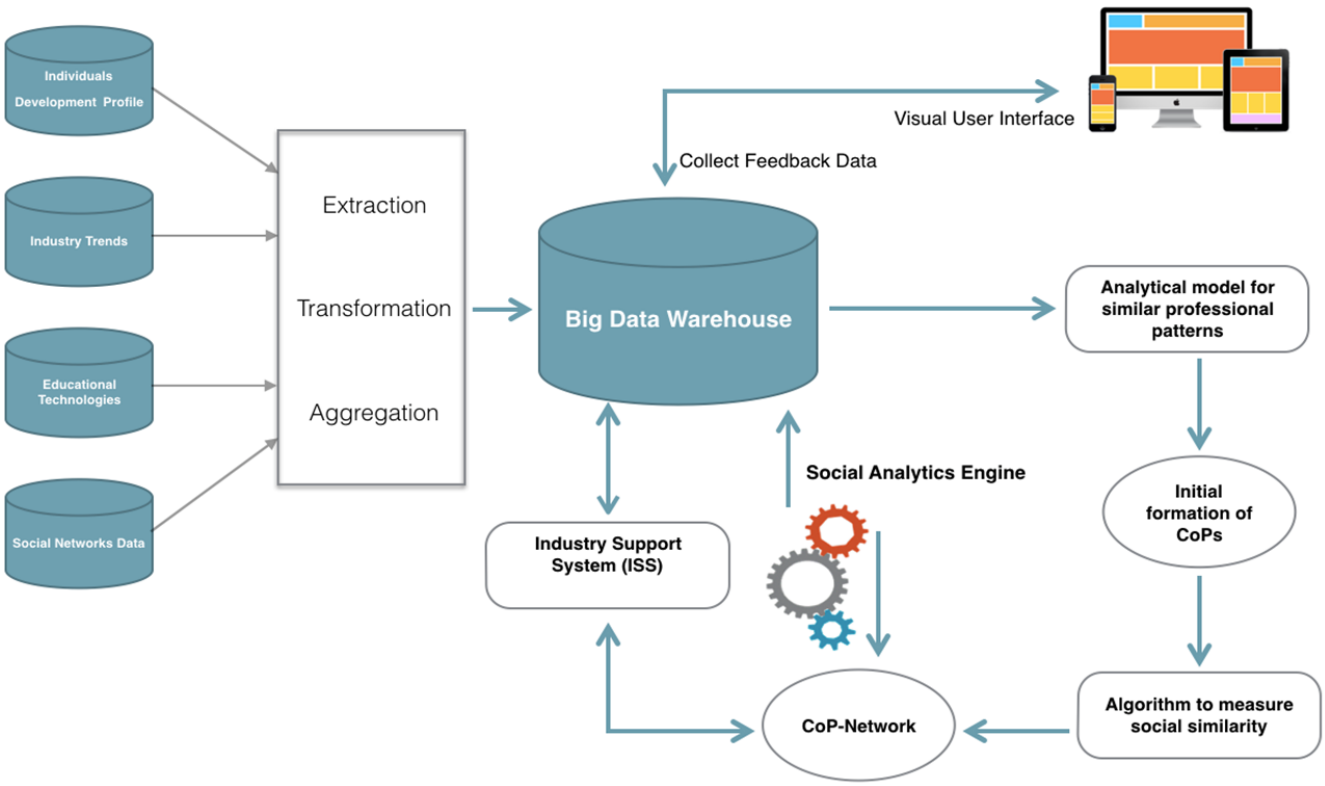

Fig. 1 Architecture of the CoP-Network construction model

V. Opportunities and Limitations

We argue that individuals' commitment to continuous learning and their ability to learn and change should be considered at the early stages of CoP-Network development in order to connect like-minded members who will be able to build mutual professional development relationships, to adopt to radical changes, and to maintain momentum on knowledge creation. Our proposed CoP-Network model investigates sustainability factor at early stage of the community construction. It semantically analyzes profiles in order to link individuals who share social interests beside their common career aspirations and concerns. While building our model, we utilize the individual preferences or career dispositions that indicate the potential active members in order to assign them to the core of the community and relay on their ability to start knowledge exchange frequently, and thus ensure the sustainability of constructed CoP-Networks. Our model also emphasizes the importance of social ties to support professional development and to guide early faculty members through their challenging start. The potential of CoP-Network to support beginning faculty's to face the 21st Century challenges and to maintain continuous personal and professional is evident by CoP and social influence theories.

Social influence simply refers to the change in an individual's thoughts, feelings, attitudes, or behaviors as a result from interaction with another individual or a group [55]. Social influence occurs when an individual changes his/ her behavior after interacting with other individuals who tend to be similar or superior. In parallel, CoPs theory argues that engagement in social interactions enhances individual development and enables the extension of the individuals' capability to a new and higher level [57]. The intersection of knowledge transfer and the collaborative learning evolving from these communities create collaborative knowledge of the community that is greater than any individual knowledge [56]; and reinforces "situated learning" that is knowing how to be in practice rather than knowing about the practice [35]-[37]. This involves the process of forming the individual identity as becoming a member of the community to participate in knowledge development. Supported with the sense of connectedness and social influence, knowledge development within CoPs can be continuous, and fluid in a cyclic pattern [58]. Accordingly, learning and change in CoPs occurs within the context of the cyclical process of DDAE: dialogue, decision-making, action and evaluation [59]. Examining the application of DDEA dynamics in CoPs explains how the participating members develop their capacity to evaluate the current practices, learn how to improve them by discussing them, make decisions based on this discussion, and subsequently implement this decision into action [58], [60]. Professionals participate in CoPs are engaged to interact and gain knowledge and skills from community members, who are

partly positioned as masters or experts. The active participation of the community members is determined by several factors that include self-interest (i.e. career development, material gain), normative considerations (i.e. shared values and vision, reciprocity), community-related considerations (i.e. a sense of belonging, a common sense of purpose, cultural dimensions), usability of technology, and leadership [61]-[63]. More censorious factors that contribute to the participants' willingness to exchange knowledge, and so to the success of CoPs, are trust and acceptance [39], [64]-[66].

The fact is that even after initial acceptance, most of the CoPs fail to stimulate members to exchange knowledge and suffer from the lack of continuous member participation, which eventually threatens their success. Further, most CoPs members are knowledge consumers rather than producers, which also threatens the CoPs suitability [67]. This is mainly because the development of knowledge within a CoP is an essential feature of it, particularly when considering the relationship between CoPs and professional expertise and competence [58], [68].

Given that the virtual CoPs survival and sustainability depend on ongoing member participation and voluntary knowledge creation contribution [66], [69], there should be a mechanism to retain the active members who are the most motivated to participate, and who most contribute by posting or commenting for other posts. Members of CoPs joined based on their practice interest and their ability to contribute to the domain. However, in order for the community to grow and have meaning, the individual members must be motivated to join and to engage with it actively by creating and maintaining information flow. In this essence, trust building is crucial as without trust, members of CoPs may be reluctant to share knowledge [70], [71]. The lack of face-to-face interaction in online environment as well as the hidden identities may lead individuals to fail to engage in the CoP, preferring to work autonomously [61]. Shifting individual membership from a peripheral participation to full membership through a process of enculturation (the process whereby individuals learn their group's culture, through experience, observation, and instruction) is another barrier, as described earlier by Wenger in [37]. Peripheral participation is described as the way to define the relations between newcomers and old-timers, and their activities, identities, artifacts, and communities of knowledge and practice; while the individual's engagement and intentions to learn and the meaning of learning is configured through the process of becoming a full participant in a socio-cultural practice [35]. This is where our model leverages the power of social influence, as in many cases, individuals tend to align their behavior with the behavior of individuals who are similar to them (i.e. their immediate neighbors in the social network rather than with the network as a whole). Our model eases the "cold start" by taking advantage of social similarity to encourage individuals to join and participate actively.

On the other hand, one of the most critical success factors of CoPs is communication, which is fundamental in the development of trust and the community. Trust is built through continued interactions to develop common values and a shared understanding [66], [70]. In addition, identifying group members with prior knowledge of each other helps to consolidate membership and develop trust. Individuals' commitment to continuous learning is another factor to sustain the collaborative culture in the CoPs, and thus, the practice improvement [72].

One extra critical challenge to CoP is predispositions as discussed in [73]. Individuals have specific preferences and predispositions, which do not disappear when they join CoPs. The existence of these predispositions suggest that CoPs may well be predisposed to the absorption and creation of knowledge and the negotiation of particular types of meaning. Thus, CoPs may become static in terms of their knowledge base and resistant to change. It is important to understand that knowledge is more readily to be adopted when it is aligned with the specific predispositions of a community and when it supports the identity and current practices; than knowledge that challenges current identity and practices [73]. This echoes Fox's [74] note that CoP theory does not explain how, in practice, members of CoP change their practice or innovate; but it confirms the impact of predispositions on community success and sustainability.

VI. Concluding Remarks and Future Work

The need for academic professionals who are prepared for the challenges of the new century has been widely advocated over the last decade to improve the quality of higher education and bridge its gap with industry. In this paper, we presented our proposed model to support professional development in higher education with a CoP apprenticeship model utilizing data mining and social networks to establish positive professional practices along the career-development path. The model uses data from different resources to construct CoP-Networks as virtual spaces to support socialized learning and practice advancement by linking individuals who share social interests beside their common career development needs. It also incorporates techniques to identify and reinforce social ties, behaviors and patterns that signify effective learning processes in the constructed CoP-Network environments. In order for the CoP to grow and sustain its purpose, the individual members must be motivated to engage actively and maintain knowledge exchanges. This is why our proposed social structure recruits potential influence from peers across CoPs to encourage full participation and keep individuals' horizons open in adjusting their career plan. Further, we aim to deploy the CoP-Network model and explore its effectiveness to improve career preparation outcomes in alignment with industry needs and the specified set of skills required for each designated professions.

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