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Using Practice Context Models to Knowledge Management in Proof-of-Concept Activities: A Contribution of Knowledge Networks and Percolation Theory

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ABSTRACT

This study introduces novel research using Practice Context Models supported by Knowledge Networks and Percolation Theory with the aim to contribute to knowledge management in Proof-of-Concept (PoC) activities. The authors envision this proposal as a potential instrument to identify network structures based on a percolation (propagation) threshold and to analyze the importance of nodes (e.g., practitioners, practices, competencies, movements, and scenarios) during the percolation of knowledge in PoC activities. After thirty months immersed in the natural PoC habitat, acting as observers and practitioners, and supported by an ethnographic exercise and a designer-research mindset, the authors identified the production of meaning in PoC activities occurring in a hermeneutic circle characterized by the presence of several knowledge networks; thus, discovering the 'natural knowledge' in PoC as a spectrum of cognitive development spread throughout its network, as each node could produce and disseminate certain knowledge that flows and influences other nodes. Therefore, this research presents the use of Practice Context Models 'connected' to Knowledge Networks and Percolation Theory as a potential and feasible proposal to be built using the attribution of values (weights) to the nodes (e.g., practitioners, practices, competencies, movements, scenarios, and also knowledge) in the context of PoC with the aim to allow the players (e.g., PoC practitioners) to have more flexibility in building alliances with other players (new nodes); that is, focusing on those nodes with higher value (focus on quality) in collaboration networks, i.e., alliances (connections) with the aim to contribute to knowledge management in the context of PoC.

Keywords: proof-of-concept practices, practices, context model, knowledge networks, percolation theory, knowledge management

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1. INTRODUCTION

Knowledge is one of the basic factors for a country's scientific and technological development (Kuramoto, 2006), which is affirmed by Borges (2006) who notes that science shapes the way we perceive the world when determining various technical, economic, and social instances.

According to Jacobetty (2010), science can be described as being composed of a set of systematic research and investigation practices, with the objective of producing a specific type of knowledge. Thus, in the search for knowledge about reality, the achievement of scientific objectivity is operated in a community-based way through increasingly vast networks of densely-related observers in a universe of collaborations stimulated by improvements in means of transport and communication. However, there are many obstacles, such as the lack of information and the existence of barriers to accessing data, among others, but there is still space to find motivation in the development of science and practices and, in our opinion, one such motivation is the **ceaseless search for the generation of knowledge** (our emphasis), especially within Proof-of-Concept (PoC) activities (Neto et al., 2018, 2019).

1.1. Demystifying PoC Activity

The applicability of PoC activities is a common practice in several areas of knowledge and can be used by different organizations for several purposes, including the evaluation of new technology products or even in the pharmaceutical industry, where the evaluation of a new drug (e.g., a vaccine) requires a period of validation of its effectiveness, which is nothing more than a PoC, or Proof of Principle, according to Schmidt (2006).

In the context of our research, we acknowledge PoC as an activity with a set of practices performed by its practitioners and consumed by organizations of validation and experimentation of products and technologies with the aim of contributing to the construction and dissemination of knowledge in the study and understanding of the performance of certain artifacts and their phenomena in a given area of knowledge (Neto et al., 2020b). Therefore, the PoC activity stimulates the production and consumption of knowledge of practitioners and organizations, as well as their communities of practice, which will typically **generate tacit knowledge** (our emphasis) (Polanyi, 2009) of their applications and business processes, where in this context we understand knowledge as "a fluid mix of framed experience, values, contextual information, [and] this becomes embedded not only in documents or repositories but also in organizational routines, processes, **practices**, and norms" (our emphasis) (Davenport & Prusak, 1998, pp. 5-6).

On the other hand, we recognize that the lack of characterization (contextualization) of practices in the context of PoC (Kendig, 2016; Neto et al., 2018), as well as a model of the context of these practices, can compromise the formation of the interpretations and understandings of its practitioners with regard to the knowledge production and dissemination as we envisage a PoC activity composed of a **set of tacit and explicit movements** (our emphasis) by its practitioners, where "these movements may constitute several practices practitioners perform across organizational networks, for learning about, experimenting and evaluating new products or technologies, in the domain of IT [Information Technology]" (Neto et al., 2020b, p. 1).

According to Kendig (2016, p. 735), PoC is a term

> frequently used in descriptions of research sought in program announcements, in experimental studies, and in the marketing of new technologies. It is often coupled with either a short definition or no definition at all, with **its meaning assumed to be fully understood. This is problematic** (our emphasis).

Neto et al. (2020b, pp. 1-2) describe several PoC studies in the domain of Information Technology (IT) and within their final results those authors demonstrate the need for further contextualization, as well as more grounded and detailed analysis of practices rather than success or failure of experiments, e.g., such as in a proposed block diagram model in sequence by Barnes et al. (2009) or simple methods. In other words, in the context of PoC, we do not envisage PoC practitioners' movements "unfolding always in a well-defined sequence" (Neto et al., 2020b, p. 12).

In the context of PoC, we do not see these movements taking place in a well-defined mode of operation that would allow certain procedures and results to be carried out in a consistent manner. On the other hand, we do visualize a set of free and specialized movements that, in some way, comprise a PoC practice, being carried out by their practitioners in the development and execution of this activity, so that they can contribute to the exploration and reflection of the behavior and performance of the technological artifacts and the phenomena under study. Thus, we question the construction of PoC being seen as a "cake recipe."

That is, we understand a "cake recipe" to mean a set of predefined instructions that, if strictly followed by its practitioner (that is, whoever makes the cake), its (final) result will always be the same (that is, the cake), regardless of the practitioner. We understand "cake recipe" to be a definition that does not fit well with the demanding context of PoCs, which more often than not resemble a convoluted research process. In addition, in the context of PoCs, we highlight the discovery, exploration, and reflection of several unexpected, unknown, unexplored, and even enigmatic phenomena during the development and execution of this activity, and we question the effectiveness of using simple recipes in the context of PoC.

Thus, we envisage that some of the PoC activities could potentially be framed (developed and executed) using agile and simple methods; however, based on our experience as practitioners and observers in the natural PoC habitat, we already noted a trend of PoC activities in the IT world, especially related to digital transformation initiatives by large organizations, which become increasingly complex and lengthy, especially due to the rapidity and complexity of technological evolution, such as with Artificial Intelligent (AI) PoCs, Cloud Computing PoCs, Containerization PoCs, and Data Storage Performance Characterization PoCs, among others.

In the context of PoC, we perceive a relevant phenomenon that exists, and is implicit in this context, involving its practitioners, the organizations, and the artifacts under study. This phenomenon represents one or more ways of seeing, interpreting, and doing things in that world, resulting in development problems in a sociotechnical context, in addition to increasing the likelihood of compromising the reliability, reproducibility, and reuse of knowledge in this activity, which may affect the proper use of that knowledge by organizations, PoC practitioners, and their community of practices.

Thus, when these practitioners respond to different areas of practice, whether indeterminate or unknown, they have several conversations (dialogues) of a reflective characteristic with the materials of their situations, such as, for example, exploration and reflection on other complex worlds (organization world), such as other information systems and their artifacts. In other words, PoC practitioners tend to remake part of their practical world (PoC), which may still reveal a **tacit set of new practices** (our emphasis) and interactions in the context of PoC. That is, a new construction and vision of this practical world, in other words, the development and execution of a PoC, on which all its practices will be based, contributes to the construction and dissemination of knowledge for the activity and, in some way, contributes to the construction of a knowledge base that can influence new constructions of new activities, which by analogy, we envisage as the construction of a large and complex knowledge network.

Hence, we can expect an improvement of the whole practice through accumulated practice knowledge and vice versa during those PoC activities. Thus, the conclusion is that we should aim to learn to recognize dialectic interactions between the practices in co-evolution and the activity itself, thus creating knowledge and transforming the activity system as a whole. This continuous and circular aspect of learning (a network) through emergent PoC practice emphasizes the critical role of sociotechnical movements such as dialogues, reflections, improvisations, and negotiations.

From a practitioner perspective, **PoC activities are anything but static** (our emphasis); rather, they are experiences that are forever evolving, where each activity has its own history, embedding 'past' phases and 'future' client expectations. Hence, we envision activity structure in a PoC context as that which is conceived of at a given moment, and it then undergoes a process of evolution, where old and new practices cohabitate, and they might be recreated and transformed so that the activity reaches its pragmatic 'format.' Activities also evolve with the improvement of mediators and object definition, inducing changes in PoC practices. Thus, we understand an important factor of productivity and competitiveness for organizations: the ability of individuals, and the organizations themselves, to create, process, and transform information and knowledge during the execution of PoC.

1.2. Proposed PoC Practices Context Model

With the aim to contribute to PoC activities, their practitioners, and their community of practice, we identified ten (10) practices in the context of PoC, within which those practices are characterized as a cycle of knowledge production (Neto et al., 2019). In other words, we identified and characterized how these practices contribute to PoC development, by mapping them in Information Systems Development problems within the Context Engineering framework proposed by Roque (2004).

Further, we developed a PoC practices context model (Fig. 1) (Neto et al., 2020b) to represent practices as an emergent sociotechnical reality, a representation of the PoC context and its practices as ongoing forms of activity, with the aim of making PoC observable and an object of explicit reasoning among practitioners and their communities of practice.

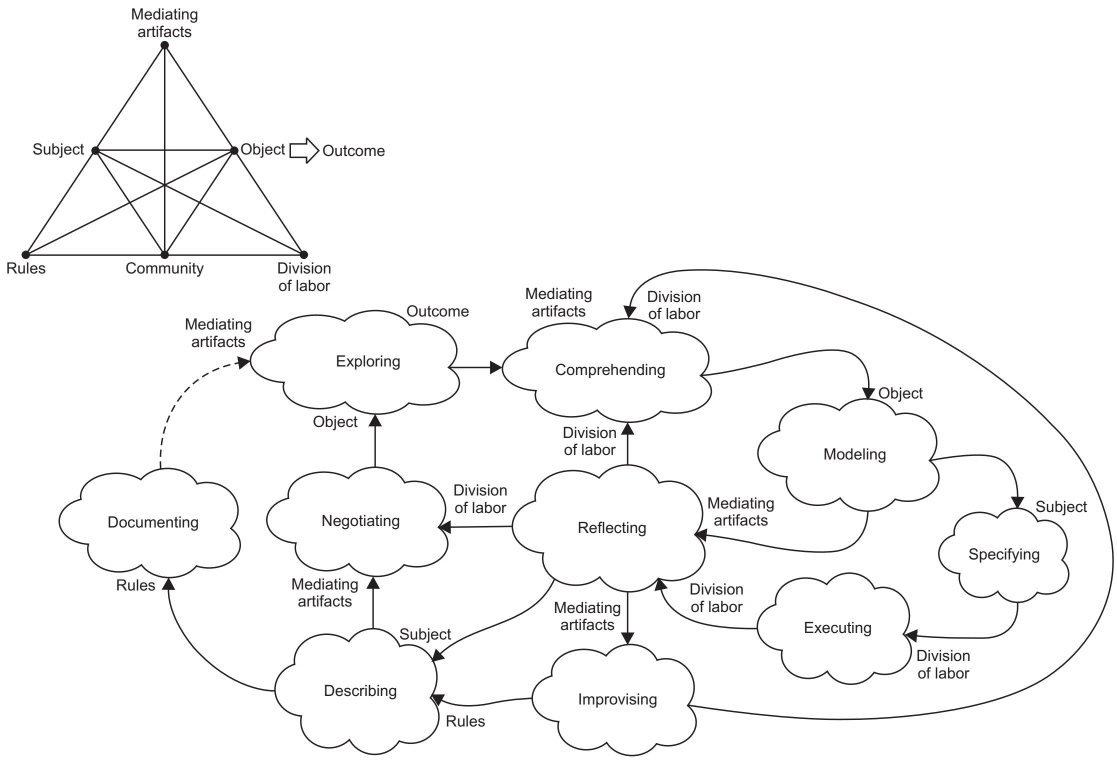

Fig. 1. Proof-of-Concept practices context model (Neto et al., 2020b).

We constructed the PoC practices context model in aiming to contribute to the discovered interactions between practices, thus fostering their co-evolution, and we frame these practices in the context of activity systems, grounded in sociotechnical phenomena, and used Activity Theory (Engeström, 1987) to substantiate our reflections on those practices and map mediators flowing between them. In other words, we position this as a language contribution to improve reflection on practice and to further enable the study of the role of emergent practices in system design.

In other words, the set of practices represented in the context model organize a set of relational flows or paths enabling the realization of a diversity of practice patterns, contingent with each PoC activity demands, in which the

> PoC knowledge is, thus grounded in a relationship among its practices, engineering the sociotechnical context that invokes its use. By collecting and assembling fragments of practitioners' movements in context, we highlight the importance of developing this PoC context model to better understand their role in the overall activity system (Neto et al., 2020b, p. 12).

Thus, we aimed to propose a PoC practices context model with respect to how those practices interact and evolve in the PoC context or how they present a relationship between a learning process in a PoC context and the Theory of Expansive Learning (Engeström, 1987, 2001, 2016). In other words, PoC context models are viewed as activity systems that are

> increasingly interconnected and interdependent, and many recent studies of expansive learning take as their unit of analysis a constellation of two or more activity systems that have a partially shared object. Such interconnected activity systems may form a producer-client relationship, a partnership, **a network** or some other pattern of multi-activity collaboration (our emphasis) (Engeström, 2016, p. 45).

Note that the above research (Neto et al., 2020b) presents a Practice Context Model in the context of the development and execution of PoC activities, whereby the goal with this proposed model was to provide a context model with the aim of acting as a compass and to 'map' those movements, whether they are acting currently or will be acting in the future, so that its practitioners can reflect on where they are and what they have done in order to take their development goals further (Roque et al., 2004).

1.3. Knowledge Networks in the Context of PoC

During the development of the PoC practices context model (Neto et al., 2020b), we learned that knowledge is not only produced and disseminated at the end of the PoC activity, but **during all the interactions** (our emphasis) between all the elements in a PoC activity (Neto et al., 2019), i.e., PoC scenarios, movements, competencies, and practices in the context of PoC), which we describe as:

- **Movements:** the actions-codes performed by PoC practitioners, regarding knowledge construction and dissemination during the PoC activity, e.g., some dialogues in a sociotechnical context
- **Competencies:** a condensed set of skills of the PoC practitioner, developed from the range of identified movements (action-codes)
- **Scenarios:** a set of dialogues and sketches that happened during the PoC activities
- **Practices:** In the context of our research, we have adopted the term of *practice* (Neto et al., 2018, p. 271) in accordance with the works of Isabelle et al. (2012) and Schön (1983). Isabelle et al. define practices as "both what people do in situations and the way they do it [in those situations]. Practices are knowing in action (Piaget, 1974), that is, [practices are] dispositions enacted in specific situations (Bourdieu, 1990)" (2012, p. 476). Furthermore, Schön notes, "I offer an approach to epistemology of practice based on a close examination of what some practitioners—architects, psychotherapists, engineers, planners, and managers—actually do" (Schön, 1983, p. viii).

We also learned that the practitioner is also not an isolated individual in a PoC context, for "the practitioner lives in a given context and interacts with that context; at the same time, the PoC practitioner influences and is influenced by the context" (Neto et al., 2020a, p. 130), a definition that strengths the hermeneutic nature in the PoC context (Neto et al., 2020a). In other words, we envisage the PoC context to be represented through a network composed of several elements (nodes), that is, the practitioners, their movements, their competencies, the PoC scenarios, and even information and knowledge produced and disseminated during the development and execution of the PoC, and their connections. For example, node A (that is, a practitioner in the context of PoC) connects to node B (that is, a practice), where that connection (link), in some way, produces knowledge and potentially disseminates it to other nodes in the PoC Knowledge Network (see Fig. 2).

Thus, according to Vygotsky, knowledge is "constructed as a result of the personal and subjective experience of an activity" which precedes knowledge, and "the technologies themselves are artifacts of practical activity… [Thus, when] the artifacts change, so does the activity [involving] new learning cycles" (Fino, 2001, p. 274), in a *continuum* learning cycle, i.e., the production and dissemination of knowledge in a PoC context is grounded by a complex knowledge network, which in this study we term as **PoC Knowledge Networks** (our emphasis).

As can be seen in Fig. 2, we present a knowledge network based on a PoC practices context model, where practitioners are connected in the practices, as well as the competencies, movements, and PoC scenarios (please refer to the Appendix for more examples). Thus, each practice produces and disseminates knowledge, which we envisage as another node in the knowledge network.

Thus, in the context of our research, we recognize a network in the context of PoC in the same sense as Menczer et al. (2020, p. 323), that is, networks are one way "to represent and study simple and complex interactions." The same authors present a network, that is,

> the simplest description of a set of interconnected entities, which we call nodes, and their connections, which we call links. The network representation is so general and powerful because it strips out many details of a particular system and focuses on the interactions among its elements (Menczer et al., 2020, p. 325).

Also, Barabási (2016, p. 45) describes a network as "a catalog of a system's components often called nodes or vertices and the direct interactions between them, called links or edges." That is, nodes represent the elements (components) in the system, e.g., the practices in the context of PoC, and the interactions between these practices are called links or edges. In other words, each practitioner who is 'connected' within a practice produces as an outcome some type of knowledge (conscious or unconscious) that serves as an additional connection to the next element in the network, thus forming (developing) a knowledge network (or several networks) in the context of PoC.

Thus, one approach is to reflect on the PoC practices context model as a complex network (graph) for knowl-

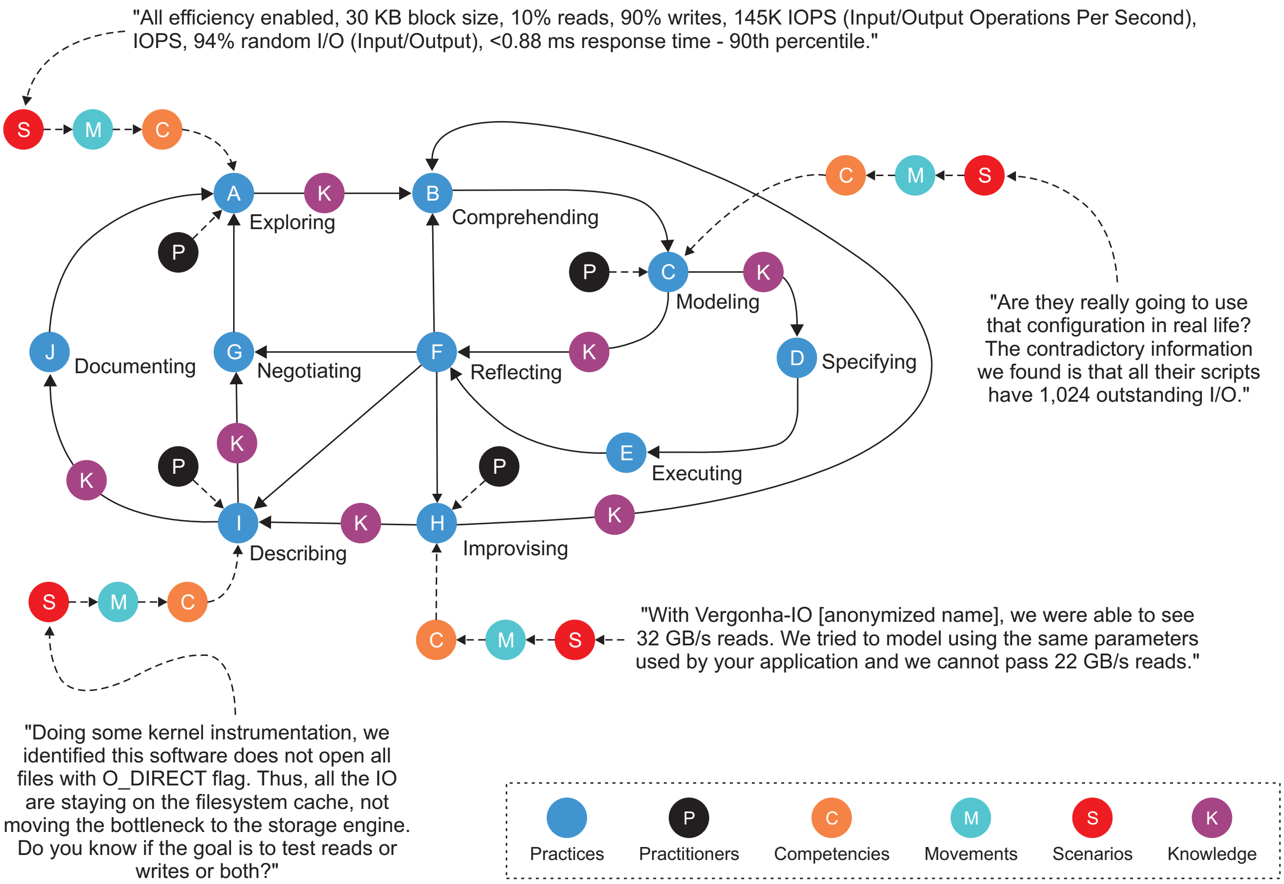

Fig. 2. Proof-of-Concept Knowledge Network based on Practice Context Model (Neto et al., 2020b).

edge production and the impact of one node on another, with the aim to contribute to the understanding of practitioners, regarding where and how they can improve in relation to practices in the context of PoC, through the construction of these collaborative networks.

We observed that the PoC Knowledge Network (Fig. 3) is formed by several networks (subnets), where each subnet (or cluster) aims to generate knowledge while employing a reuse protocol and open characteristics, i.e., aiming to allow other networks to use each of the networks.

As can be seen in Fig. 3, players 1 and 2 (PoC practitioners) form a network (Network A) during the practice of Exploring. This network produces some knowledge (Knowledge A), which can form a new vertex (node) for any other network. We can observe the same operation in the practice of Documenting and Improvising, the formation of networks called Network U and Network Y, respectively. We also can observe the creation of a network (Network n) composed of two subnets (Network B with players 4 and 5 and Network C with players 1 and 3) through the practice of Describing.

However, the subnet Network C produces some specific knowledge (Knowledge G) which may or may not have influenced the construction of knowledge for the entire network. In other words, the product of a network is the knowledge produced, which may or may not be reused by other networks. The networks (graph) represented in Fig. 3 can exhibit a high degree of heterogeneity, with fluctuations in connectivity parameters that span several orders of magnitude (see later in Fig. 4).

1.4. A Borrowed Theory from Physics: Introducing Percolation Theory in the Context of PoC

To the best of our knowledge, over the past two decades, Percolation Theory (Sahimi, 1994; Stauffer & Aharony, 1992) has been used to explain and model a wide variety of phenomena that are of industrial and scientific importance. According to Sahimi (1994, abstract section), examples include "characterization of porous materials and reservoir rocks, fracture patterns and earthquakes

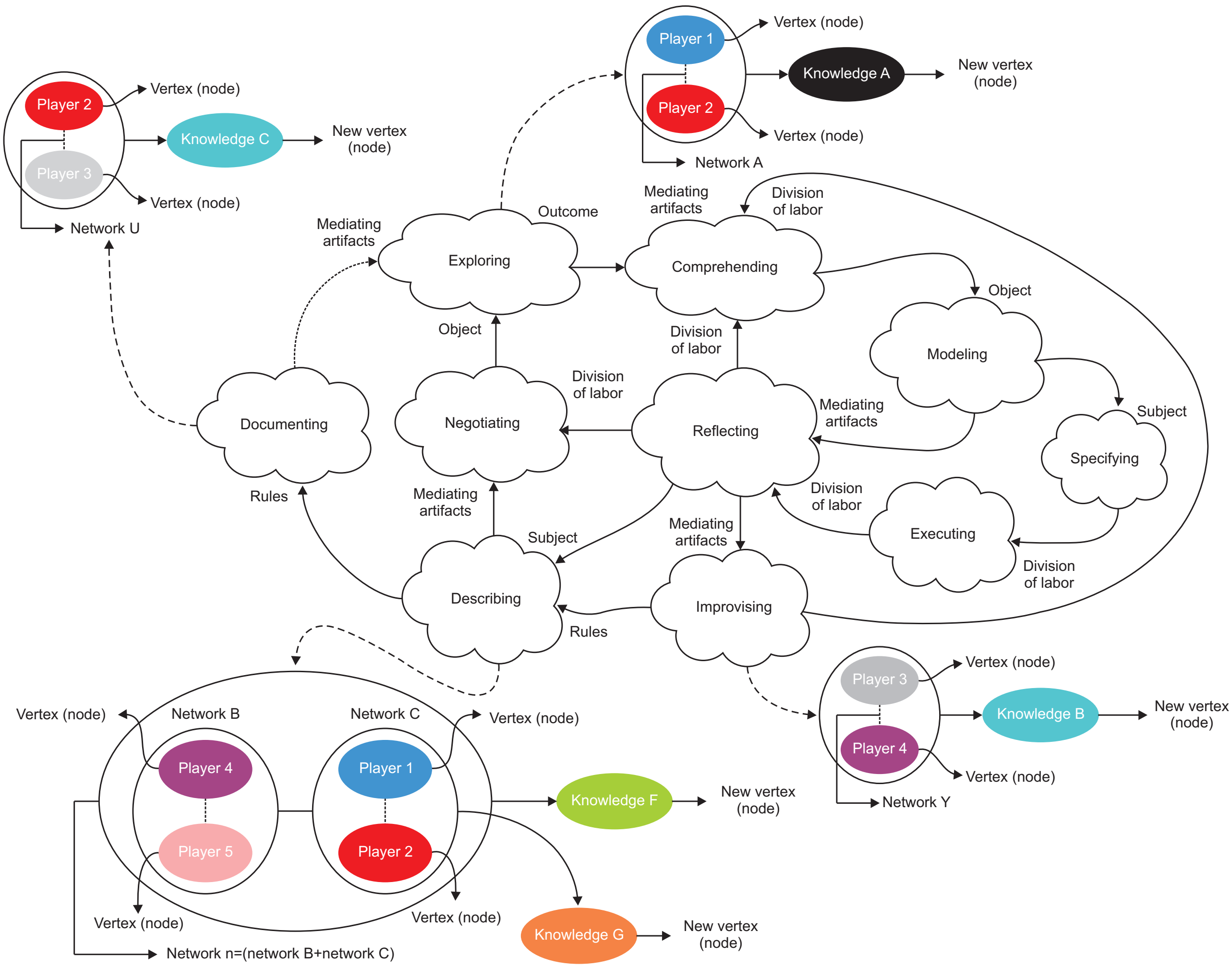

Fig. 3. Proof-of-Concept Knowledge Network and its sub-networks.

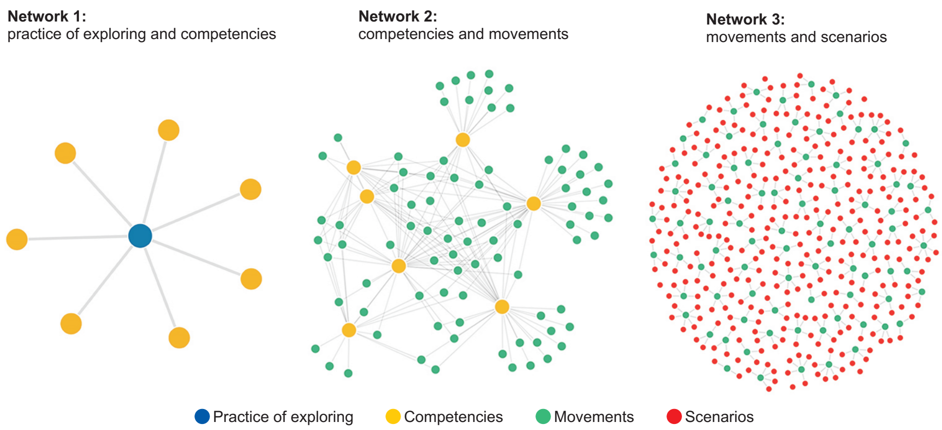

Fig. 4. Several Proof-of-Concept Knowledge Networks based on the practice of Exploring.

in rocks, calculation of effective transport properties of porous media permeability, conductivity, diffusivity, etc., groundwater flow, polymerization and gelation, biological evolution, galactic formation in the universe, spread of knowledge, and many others."

Also, according to Piraveenan et al. (2013, p. 1), Percolation Theory is "attractive because it provides connections to several well-known results from statistical physics, in terms of percolation thresholds, phase transitions, long-range connectivity, and critical phenomena in general." However, several studies, such as those of Popescul (2012) and Block et al. (2015) present a **new way of thinking about Percolation Theory** (our emphasis).

According to Popescul (2012, p. 445), Percolation Theory promotes "thinking regarding the relation between innovation and knowledge using a model borrowed from Physics, in aiming to prove whether knowledge resources can 'flow' (be percolated) in a network or a grid, in order to be transformed into technological innovation." Block et al. (2015, p. 23) note that "the main specificity of percolation is connectedness, as percolation theory is a general mathematical theory of connectivity. In physics, percolation processes result from the counteraction of two forces – connectivity and receptivity" and discuss their research as a "model of interaction within the company [that] is built on the percolation processes model, which was developed in Physics and represents a universal mathematical apparatus for researching clustered and non-clustered environments."

In the context of our research, we intend to reflect on the possibility of using Percolation Theory in conjunction with Knowledge Networks in aiming to contribute to the identification and analysis of the number of connections (links) between nodes in the knowledge network, and as a way of 'measuring' the capacity of these nodes regarding the dissemination (propagation) of information and knowledge through a PoC network. Thus, we expect to know how properties such as connectivity and receptivity of the knowledge network can be used to explain the process of knowledge sharing within an organization that relies on several PoC activities, with the aim to contribute to their digital transformation and technology innovation.

In other words, we aim to provide a theoretical and novel proposal based on Practice Context Models supported by Knowledge Networks and Percolation Theory, aiming to acknowledge the creation of complex networks with strategic and collaborative characteristics for the production and dissemination of knowledge, and contribute to knowledge management in PoC activities.

2. RESEARCH QUESTION

The motivation for our research was provided by the opportunity to propose a novel perspective on how to manage knowledge in the context of PoC, with the aim to contribute to knowledge management in PoC activities and provide a distinct reflection on how the knowledge can be constructed, disseminated, and potentially measured, through Practice Context Models with the support of Knowledge Networks and Percolation Theory.

According to Fanfan (2012, p. 118), identifying and distinguishing knowledge – knowledge management – is "any process or practice of creating, acquiring, capturing, sharing, using and evaluating knowledge wherever it resides." However, one question has motivated us to continue and advance our research in the context of PoC, thus, we start our research with the following question: "How can we 'manage knowledge' in the context of PoC?"

We understand that in order to present a proposal with the aim to contribute to knowledge management in PoC activities, initially it is necessary to define a networking core model to be used, identify and classify its nodes and connections, and later, construct a model with the ability to "measure" these nodes.

In other words, we need to define (1) a Practice Context Model to be the core for the knowledge network, (2) identify and classify the nodes and their connections in that knowledge network, and (3) present a conceptual proposal with the aim to contribute to the evaluation of these nodes. Therefore, we present our two main objectives in this research:

- **Objective 1:** identify, classify, and map the connections of the elements (PoC scenarios, movements, competencies, and practices) in a PoC context with the support of Knowledge Networks
- **Objective 2:** a proposal to "measure" the nodes (PoC elements) distributed in those knowledge networks with the support of Percolation Theory

As can be seen in Fig. 1, we aim to reflect on the PoC practices context model (Neto et al., 2020b) as our network core, where each practice is represented in a cloud (e.g., Reflecting) and the set lines represent the interactions (flows) between those practices, which would translate to some way of transporting information and knowledge and its ways of obtaining among those interactions. In other words, in the context of PoC, each activity structure relates practitioners to an object or motive of each activity in the PoC context.

We envisage PoC practices playing an important role in mediating between practitioners (as subjects) and how they organize, regulate, and use instruments to achieve the PoC result. Through these mediations, results must be obtained and knowledge about the object of the PoC gets produced. Thus, turning the PoC object into knowledge is a shared motive across all PoC interactions (flows or connections in a network), and not only at the end of the PoC activity.

Due to the importance of knowledge, we understand that it is necessary to change our thinking with regards to organizational, strategic, and competitive innovation in organizations (Klaus et al., 2016), especially in how to execute and view PoC activities. From another perspective, the creation of the organizational knowledge is consolidated, in terms of organizational processes, with the purpose of assisting and amplifying the creation of knowledge, through the individuals in the organization, as part of their knowledge networks. Through this line of thought, it is possible to identify and distinguish between the different levels of social interaction in a PoC network, in which knowledge has been transformed and recognized, i.e., identifying and distinguishing the different levels of knowledge in the practices of the PoC context.

We also strengthen our understanding (vision) that PoC can be understood as "forming a cycle of dialectical reproduction of activities oriented towards the enaction of a body of knowledge, based on the interpretation and comprehension of all parts" (Neto et al., 2020a, p. 130) by its practitioners, which emphasizes the hermeneutic nature of the PoC context which, according to Gadamer (2013), is the philosophical theory of knowledge which states that "all cases of understanding necessarily involve both interpretation and application; a definition that we emphasize and which we consider to be lacking in the reflection and consciousness of PoC practitioners" (Neto et al., 2020a, p. 129).

3. RESEARCH METHOD

In this study, we aim to contribute to the body of scientific literature with regard to how the PoC practices context model (Neto et al., 2020b), with the support of Knowledge Networks and Percolation Theory, can contribute to knowledge management in PoC activities.

Thus, we based our research method on the characteristics of qualitative research acting directly within the regular environment of the PoC practitioners (which we term as a natural PoC habitat), where there is a direct source of data and the researcher becomes an instrument of research. Thus, the PoC environment and PoC practitioners were holistically observed and analyzed, while not being reduced to variables; rather, they were observed as a whole.

In other words, we describe our research method as an interpretive (qualitative) paradigm of an inductive and descriptive logic, being characterized as an exploratory and an ethnographic research (Angrosino, 2007; Coutinho, 2015; Gil, 1989; Lazar et al., 2017), within which we emphasize the correspondence of the researcher with the reality to be investigated, that is, the context of the PoC and its practices, where the construction of a theory is developed in an inductive and systematic way starting from its own natural habitat, as empirical data emerge (Creswell, 1994, 2012; Creswell & Creswell, 2018).

3.1. Objective 1: Identify, Classify, and Map the Connections in a PoC Context

The data collection resulted from our direct immersion in the natural PoC habitat. We totally immersed ourselves in the PoC world, over a period of approximately thirty (30) months, and analyzed how different IT companies, to a total of five (5), develop and execute PoC activities concerning several organizations (potential customers), based on the following criteria: (i) their ability to execute and develop the PoC activities, specifically in the domain of IT data infrastructures; (ii) their capacity with respect to the exposure and diversity in the development and execution of PoC activities, where we opted for companies that could offer diversity in the context of PoC activities, e.g., evaluating the performance of a data technology artifact; studying new features of high-availability scenarios, resilience, and data replication architectures; comparing different artifacts and technologies; among other scenarios; (iii) their ability to carry out these activities in parallel and not just as 'one or another eventual activity,' i.e., we opted for companies that could actually perform multiple and diverse PoC activities as their main operating factor; and (iv) in order to accept our observations and direct participation in PoC activities performed by those companies along with their practitioners.

We started our research as observers based on an ethnographic exercise (Lazar et al., 2017) in the natural PoC habitat, which according to Angrosino (2007, p. 14) is the "art and science of describing a human group — its institutions, interpersonal behaviors, material productions, and beliefs." In other words, this ethnographic exercise was based on the "notion that true understanding of complex human practices and contexts requires in-depth, engaged study" (Lazar et al., 2017, p. 231), in which we visualize PoC practitioners who often describe what they do in terms of movements and practices in the context of PoC, in a way that is actually inaccurate, possibly due to a lack of awareness or understanding of what they would need to communicate about what they are aiming to accomplish (e.g., PoC outcome – results) (Neto et al., 2020a).

As observers, we were interested in identifying, characterizing, and tracking the concepts used by practitioners in the development and execution of PoC activity with the aim to contribute to our explicit reflections and interactive constructions regarding how those PoC elements (network nodes) evolve and relate in the flows (network connections) of information and knowledge. Therefore, we sought to incorporate our observations in a language that could be referenced and build the connections in the context of PoC. In this way, we observe what happens, listen to what is said, and ask specific questions through informal dialogues, thus recording this information through our personal notes and sketches (anonymized data) in a non-technical language (Angrosino, 2007; Hammersley & Atkinson, 2007; Lazar et al., 2017). In fact, we seek to gather whatever data are available to clarify the objectives that are the emerging focus of our investigation.

Notwithstanding, we opted to act based on two mindsets in the natural PoC habitat: non-interventionist (as observers) and interventionist (as practitioners). Thus, we worked collaboratively with diverse practitioners in the research domain, aiming to reflect on how the interactions (flows) between the PoC practices could contribute to knowledge management in the activity, in order to fulfill our objectives in this research. As both observer and practitioner, with the aim to accomplish the first objective in this research, our interest was in tracing (identifying and characterizing) how those concepts could help make explicit reflections, and our method was based on interactive observations and constructions on how those practices evolve and relate in information/knowledge flows across the PoC activity (Neto et al., 2020b), especially with respect to knowledge management in the context of PoC.

Later, we immersed ourselves again in the natural PoC habitat with a designer-researcher mindset (Hevner, 2007), aiming to develop our research based on interactive and practical constructions of how those nodes evolve and interact in that specific context (i.e., the movements used in PoC during a discussion of performance on a data storage system between an expert on PoC and a potential customer). In other words, when identifying a PoC practitioner or practice (node) being used in PoC, we observe its interactions (flows) with the next actions, i.e., competencies, movements, and scenarios, performed by PoC practitioners.

Thus, we created and analyzed an interactive design cycle (Hevner, 2007) within which we continually adapted a knowledge networking model through the next PoC activities, in order to discover how those practices, movements, competencies, and scenarios relate and evolve during execution, aiming to characterize a network in the context of PoC. That is, we contextualize the PoC activities during the translation phase when a PoC practitioner translates the phenomena of one world (e.g., organization world) to be reproduced in a different world (PoC world), and the "transition phase" (i.e., from the organization world to a PoC world) when a practitioner changes, combines, or improvises the phenomena in the PoC context between practices.

In summary, we aim to identify and characterize in those activities all the PoC connections in a manner relevant to interpreting and structuring action and the impact in the context, with respect to the production and dissemination of knowledge, with the aim to map the practices and their model elements in a knowledge network supported by the PoC practices context model. Also, we aimed to predict what are the next steps in modeling the context of PoC, especially regarding those connections, helping to perceive potential cluster nodes and their relations (connections) with the aim to identify and characterize the formation of the knowledge networks in the context of PoC.

3.2. Objective 2: A Proposal to "Measure" the Nodes Distributed in PoC Knowledge Networks

On the other hand, and with the aim to accomplish our second objective in this research, to measure those nodes distributed in the knowledge network, we needed to seek supporting evidence in a review of the literature. We found several and interesting studies in the field of physics (Sahimi, 1994; Stauffer & Aharony, 1992) related to Percolation Theory which describe the properties of those clusters (networks and sub-networks) where a percolation process consists of the propagation of the state from one vertex (node) to other vertices (nodes), which after being 'active' continue with the propagation process (percolation).

Thus, we envision this to be a way to understand whether this specific network is collaborating or not with the production or dissemination of knowledge within the practice in the context of PoC. In other words, the collaboration (activity) ends when there are no more vertices (nodes) in the network that can be activated, that is, when the network does not produce more knowledge. However, there are a number of centrality measures (Paula, 2015; Piraveenan et al., 2013) to determine the "importance" of a single node (vertex) in a network (graph) or a subnet (sub-graph), but one potential approach to categorize and calculate the generated dynamic network is to use Percolation Centrality (Piraveenan et al., 2013, p. 3), which "measures the importance of nodes in terms of aiding the percolation through the network" and specifies in detail the importance of nodes (i.e., practices) in terms of their percolation (propagation) through the generated graph (i.e., PoC practices context model).

In order to accomplish our second objective, we seek the support of a Percolation Theory model, which we envisage to be useful for calculating a **learning curve** (our emphasis) for each knowledge network in the context of PoC, thus aiming to propose and address a dynamic percolation model in each network which could contribute to capturing the "relative impact of nodes during (possibly partial) percolation" (Piraveenan et al., 2013, p. 2) during PoC activities, and contribute to knowledge management in those activities. We found in the model proposed by Piraveenan et al. (2013) a measure of centrality (percolation centrality) with the aim to analyze the importance of nodes during percolation in networks, especially the relative impact of those nodes in additional percolation, e.g., in the spread of an infection, or in the context of our research, in the 'spread of knowledge' in PoC activities. That is, we envisage this percolation centrality model which becomes a useful measure and precisely in scenarios when an early intervention is needed, e.g., in order to relocate a practitioner from one practice to another or to strengthen a specific experiment with a practitioner who has greater 'knowledge percolation.'

Thus, we see percolation as an analogy to a "contagion" that occurs in complex networks in several scenarios. For example, in the case of a viral infection, it can spread through people's social networks. Likewise, the spread of diseases can also be considered as a higher level of abstraction, covering several networks, e.g., a network of cities connected by roads. In the same way, computer viruses can spread over computer networks and the whole Internet. Therefore, in all of these scenarios, somehow a "contagion" happens and spreads over the links of a complex network, changing the 'states' of the nodes as it spreads.

In the context of our research, we envisage the use of Percolation Theory models with the aim to contribute to the development of a proposal, albeit theoretical, of how communities of practice could identify, characterize, and measure this "contagion" in the PoC Knowledge Networks, where this "contagion" refers to the information and knowledge spread across all the connections of those networks which somehow impacts the production and dissemination of knowledge.

4. RESULTS AND DISCUSSION

Our research was based on our direct participation (Angrosino, 2007; Lazar et al., 2017) in multiple PoC activities, totaling eighty (80) – fifty (50) in total as non-interventionists (observers), and thirty (30) in total as interventionists (practitioner) – working collaboratively with several PoC practitioners, ninety-seven (97) in total. As a result, we observed ten (10) practices, twenty-two (22) competencies, one hundred and ten (110) movements (action-codes) and four hundred and forty-three (443) data points, specifically three hundred and ninety-one (391) PoC scenarios (e.g., dialogues) and fifty-two (52) sketches in the context of PoC. After mapping all the potential interactions (connections) between the practices, competencies, movements (action-codes), and scenarios (Neto et al., 2019) in the context of PoC, we identified a total of five hundred and eighty-five (585) nodes and one thousand and sixty-nine (1,069) connections (links) among all the practices, competencies, movements, and scenarios based on the PoC practices context model (Neto et al., 2020b), composing a large and complex knowledge network (Table 1).

Phelps et al. (2012) describe networks as "a set of nodes — individuals or higher level collectives that serve as heterogeneously distributed repositories of knowledge and agents that search for, transmit, and create knowledge — interconnected by social relationships that enable and constrain nodes' efforts to acquire, transfer, and create knowledge" (Phelps et al., 2012, p. 1117), i.e., we envisage these PoC networks as **knowledge networks** (our emphasis).

In other words, Davenport and Prusak (1998, p. 116) note "there are 'knowledge networks' for each key practice." Thus, each connection (link) in those networks demonstrates a **higher probability for the production and dissemination of knowledge** (our emphasis) through the connected nodes which are represented by the practices, the competencies, the movements, and the scenarios, with a potential influence over the whole network.

Further, with the aim to demonstrate some of the knowledge networks found in the context of PoC, we illustrate several networks (Fig. 4) based on the practice of Exploring (Neto et al., 2020b, 2019) composed of one (1) practice, seven (7) competencies, eighty-five (85) movements, and three hundred and twenty-five (325) PoC

Table 1. Nodes and links (connections) in the context of Proof-of-Concept

Practices	Nodes	Links
Practice of Exploring	418	523
Practice of Comprehending	358	443
Practice of Modeling	446	565
Practice of Specifying	477	628
Practice of Executing	540	836
Practice of Negotiating	505	737
Practice of Improvising	488	761
Practice of Reflecting	527	751
Practice of Describing	425	550
Practice of Documenting	490	640

scenarios, totaling four hundred and eighteen (418) nodes and five hundred and twenty-three (523) connections (links).

As can be seen in Fig. 4, Network 1 represents a network constituted by 8 nodes (one practice and seven competencies). Network 2 represents the 7 competencies and their respective movements (action-codes), and Network 3 represents the movements (action-codes) and PoC scenarios in the practice of Exploring.

Thus, we envisioned and learned about these nodes and their connections (links) creating and promoting knowledge; and knowledge that will reproduce other nodes and connections, thus reifying and evolving knowledge of the practice in PoC activities, where "[o]ne, knowledge is a function of a particular stance, perspective, or intention. Second, knowledge, unlike information, is about action. It is always knowledge 'to some end.' And third, knowledge, like information, is about meaning. It is context-specific and relational" (Nonaka & Takeuchi, 1995, p. 72).

4.1. The Production of Meaning in PoC Knowledge Networks

However, during our observations and participation in the natural PoC habitat, we discovered an interesting phenomenon in regard to the production of discourse and knowledge in the context of PoC being based on the relationship of the parts with the whole and vice-versa (that is, think here of the nodes and their connections in a network) or the mediators with their context, that is, elements that allow the production of meaning (Roque, 2004).

In this way, we understand that reality capture is performed when the practitioner in the context of PoC really seeks to perceive the world in which he/she lives, not only based on his/her *sui generis* perspective, but also in relation to the different perspectives and actions of other actors in the context of this activity, where we emphasize that this set of different perspectives in the context of PoC enhances, and at the same time provokes, new thoughts and reflections in order to contribute to the formation and improvement of knowledge networks in the context of PoC.

In other words, the production of meaning is grounded by the hermeneutic circle (Gadamer, 2008, 2013; Neto et al., 2020a; Nixon, 2017; Schmidt, 2012) and based on the movements of interpretation and comprehension using the knowledge networks in the context of PoC, where during these movements of interpretation and understanding, practitioners and their activities create and promote knowledge, where that knowledge contributes to their own evolution, in addition to the production of new activities (Fig. 5).

As we can see in Fig. 5, we present one scenario observed during our immersion in the PoC world. The scenario was composed of two practitioners working in the context of PoC supported by the formation of cycles of dialectical reproduction of their activities, oriented towards the action of a body of knowledge based on the interpretation and understanding of all parties (or the knowledge network nodes) in the context of PoC. Note that during our observations and participation in the natural PoC habitat, we identified several passages in the scenarios in the PoC that supported our understanding regarding the hermeneutic nature of this activity.

In one of these observations, we highlight a particular situation where a customer would like to use a synthetic workload tool for simulating I/O (Input/Output) operations with a very large number of threads (processes) in order to evaluate a new technology, which in our opinion is somewhat absurd. Upon receiving this request, the group of PoC practitioners interpreted it as unrealistic and based on "their knowledge" (production of meaning), it is unnecessary to use an amount of 65,536 threads in a performance evaluation (I/O and latency) experiment of a data storage system (Almeida, 2006; Neto, 2004).

However, from the customer's point of view, we noticed an impasse, where "after numerous discussions between the solutions architects and the PoC group, the customer was reluctant to change the proposed experiments, especially the specific experiment related to the 65,536

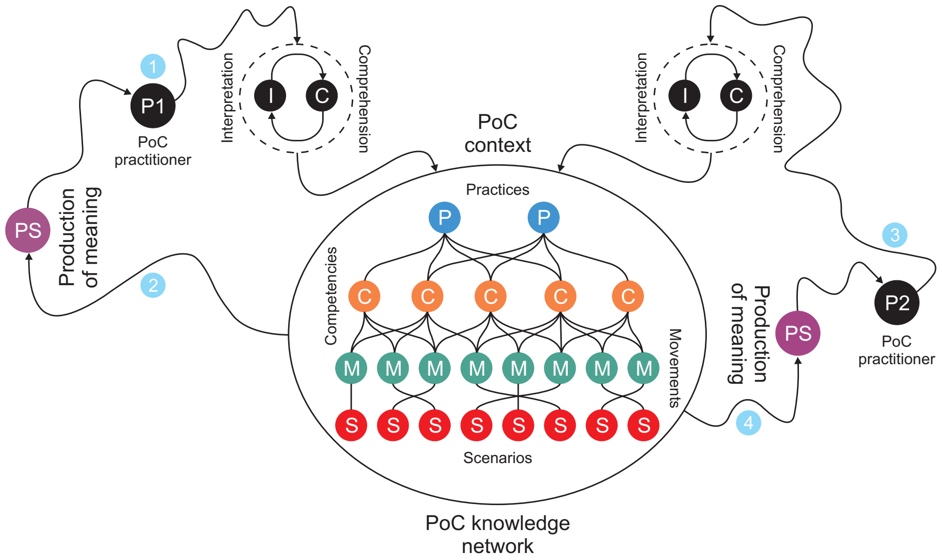

Fig. 5. The production of meaning in the context of Proof-of-Concept (PoC).

threads" (Neto et al., 2020a, p. 129).

Thus, this specific experiment was rejected by the group of PoC practitioners, who initially understood that this number of threads (processes in parallel) characterized a misconfiguration (that is, the non-representation) of any information systems in reality.

In other words, the interpretation/comprehension (hermeneutic cycle) of this group was as follows:

> ...it is not necessary to use this number of processes in parallel [65,536 threads] for the generation and simulation of the data for performance measurement in data storage systems. Also, the results obtained could express an outcome that could be misinterpreted, thus formalizing a deficient knowledge based on these results (Neto et al., 2020a, p. 129).

In the course of countless discussions between the technical staff of the customer, the business partner, and the group PoC practitioners regarding this specific experiment (65,536 threads), we identified several recurring cycles of interpretation and understanding for the production of meaning (again, the hermeneutic cycle). Thus, we understand that in order for this production of meaning to make "some sense," an engineering of a context becomes necessary. That is, we emphasize that these cycles of interpretation and understanding, the production of meaning, and the engineering of a context, that is, a hermeneutic circle associated with the PoC context, happened naturally in the course of the countless conversations between these actors.

At the end, after several discussions and recurring cycles of interpretation and understanding in the context of the PoC (Fig. 5), the group of PoC practitioners realized that the customer's intention (i.e., the specific objective) with this particular experiment **was not to evaluate the performance** (our emphasis) of the data storage solution, but to understand and explore how this technology would behave under an abnormal condition of use (i.e., how this technology would behave 'dealing' with 65,536 processes in parallel). The customer explained that, in the past, they had this experience with another solution from a different manufacturer, and when that situation happened due to a misconfiguration application, the solution was virtually unusable, consequently impacting their core business. So that would be why they would like to learn and understand how this new data storage solution would behave under the same conditions.

As can be seen in Fig. 5, we learned that every understanding in the PoC context is born with prejudices (preconcepts), where practitioners adopt, modify, or reject these prejudices as the development of this activity continues. Thus, we envisage this development proceeding in a hermeneutic circle (Gadamer, 2013) (see the different circles of interpretation and comprehension in Fig. 5) grounded by the formation of knowledge networks in the context of PoC.

In other words, we define a movement, which is precisely a back-and-forth movement between those prejudices that lead to practices in the context of PoC and the knowledge that we derive from that movement. Thus, if there were no prejudices to modify, understanding would be impossible and unnecessary. However, the practitioner in the PoC context is not an isolated node in the knowledge network, where that practitioner and the knowledge live in a given context (network). Both interact with this context (network); at the same time, they influence and are influenced by the context (those networks) (Neto et al., 2020c).

Therefore, the hermeneutics presents

> itself in the present time, in the culture of a particular group, to seek the meaning that comes from the past or even the present, from a worldview of its own, involving in a single movement the being who understands and also what is understood, which is specifically what happens in the PoC world (Neto et al., 2020a, p. 130).

Thus, reflecting on what happens in that world supported by hermeneutics can reveal problems and help clarify and understand the dimension of the production of meaning or the phenomena inherent in the context model of PoC practices (Neto et al., 2020c), especially with the formation of those knowledge networks.

4.2. Connecting PoC Knowledge Networks and Percolation Theory in the Context of PoC

In the same sense, in the context of PoC we learned that the production and dissemination of knowledge are dynamic through social interactions (Nonaka et al., 2000) among its practitioners across the entire network. Thus, we envisioned flows of information/knowledge also when PoC practitioners (acting as nodes in a network) "spread" from one to another implicit and explicit (tacit) knowledge throughout PoC Knowledge Networks. In other words, using an analogy as an example, we can represent these flows of information/knowledge in PoC Knowledge Networks as a "contagion" of a virus on a computer network or a dissemination (spread) of information in a social network.

As can be seen, PoC through its practitioners (players) produces results and these results (Neto et al., 2019, 2020a, 2020b), such as new scenarios, new movements, new competencies, new practices, new knowledge, even new practitioners, or any element could be represented as new nodes (vertices) to be used collaboratively in the network itself, parts of the core network, or in multiple networks, which can be represented through graphs (Feofiloff et al., 2011; Gonçalves, 2007; Jurkiewicz, 2009; Lucchesi, 1979) as a mathematical structure that is used to represent the relationships between clusters (objects).

Thus, using the terminology of Graph Theory (Feofiloff et al., 2011; Lucchesi, 1979), it can be said that the distribution of $P(k)$ connectivity that gives the probability that one vertex (e.g., practitioner, practice, or knowledge) is connected to k other vertices, is mathematically described by a power-law $P(k) \propto k^{-\gamma}$, where the factor γ will depend on the scale of the considered network.

The network growth begins with random graphs of $k0$ vertices, and each vertex k could be considered as just a simple new practitioner, new movement, new practice, or knowledge generated in the context of PoC. The growth hypothesis is incorporated assuming that in each unit of time t a new vertex is added to the graph, connecting to k different vertices. At each time point t each vertex k has a probability p of acquiring a new connection, that is, knowledge was generated or propagated to k other vertices, or a new PoC practitioner had connected to the network, with the objective of establishing new alliances and/or consuming/producing knowledge.

According to Piraveenan et al. (2013), the percolation state of a node (vertex) k at time t is given by x_k^t. Specifically, $x_k^t=0$ indicates a non-percolated state at time t; where $x_k^t=1$, a fully percolated state; or we can say that $0<x_k^t<1$ would be a partially percolated state at time t (Fig. 6).

Note that we use hypothetical values to demonstrate the percolation states of each node, which could be determined (and this is to be explored in future works) as, for example, the frequency of PoC movements for each practitioner or the amount of evidence (the total circulation inside a particular network), such as the number of documents, results, consultations, publications, or participations in PoC activities, among others. We undoubtedly recognize that more research is needed in this particular area regarding the percolation states in these networks, i.e., it is essential to define, depending on particular PoC practices, how to evaluate each node in the PoC network or the node percolation states in a PoC Knowledge Network, among other scenarios. Also, we recognize the need for further study in order to analyze the 'culture' of knowledge sharing in the context of PoC due to its heterogeneity and complexity. It is known that the type of knowledge in the context of PoC practices implicitly or tacitly influences the route choice and speed of knowledge sharing. It would be interesting to investigate further what types of knowledge and what practices affect the percolation threshold.

Thus, as can be seen in Fig. 6, this particular network (the subnet inside the dotted lines) has five vertices (nodes in green), where each vertex (node) has its respective

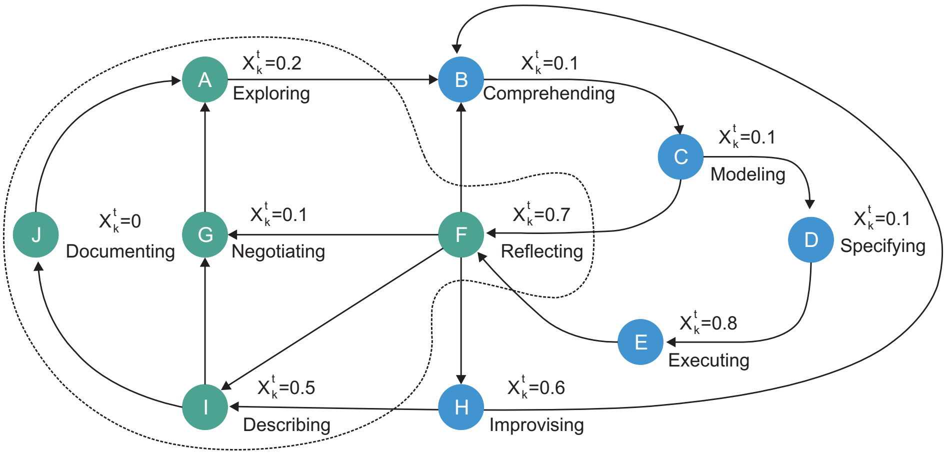

Fig. 6. An example of vertices (nodes) and Percolation states (values) in a Proof-of-Concept Knowledge Network.

state (weight) of percolation as: **Vertex F** has a percolation status (weight) of x_k^t=0.7; **Vertex I** has a percolation status (weight) of x_k^t=0.5; **Vertex J** has a percolation status (weight) of x_k^t=0; **Vertex G** has a percolation status (weight) of x_k^t=0.1; and **Vertex A** has a percolation status (weight) of x_k^t=0.2.

However, Vertex F (x_k^t=0.7) has a percolation status (weight) greater than vertex I (x_k^t=0.5), whereby we could conclude that the information or knowledge generated from that vertex or existing in it has a "higher probability to percolate," that is, propagate to vertex I. Likewise, we could conclude the same with respect to vertex I (x_k^t=0.5) in relation to both vertices J (x_k^t=0) and G (x_k^t=0.1).

In the case of vertex J (x_k^t=0), we could conclude that nothing percolates, that is, nothing passes through this vertex, since it has a zero percolation state (weight). In the case of Vertex G (x_k^t=0.1), in relation to vertex A (x_k^t =0.2), we can conclude that the "probability of percolating is low," because the percolation state (weight) of this vertex is lower in relation to the subsequent vertex (Vertex A).

Thus, the main purpose of Percolation Centrality, according to Piraveenan et al. (2013, p. 3), is based on the fact that "a node may very well be centrally located in terms of betweenness centrality or another centrality measure, but may not be 'centrally' located in the context of a network in which there is percolation," e.g., two practitioners (players 1 and 2) and their impact on other practitioners (vertices) in the entire network (graph). According to the same authors, there is a series of centrality measures that "exists to determine the 'importance' of a single node in a complex network. However, these measures quantify the importance of a node in purely topological terms, and the value of the node does not depend on the 'state' of the node in any way" (Piraveenan et al., 2013, p. 3).

As can be seen in Fig. 3, there are several clusters, that is, several groups of players (i.e., PoC practitioners) and their vertices (e.g., practices). This potential network is based on Percolation Centrality (Piraveenan et al., 2013) and focuses on determining **how important** (our emphasis) (regarding quality) the node (player or knowledge) is in the complete percolation process, which corresponds to the "spread of knowledge to other networks," i.e., PoC Knowledge Networks. The Percolation Centrality proposed by Piraveenan et al. (2013, p. 4) of a given node (vertex) k at time t can be represented by (1):

$$PC^t(k) = \frac{1}{(N-2)} \sum_{s \neq k \neq r} \frac{\alpha_{s,r}(k)}{\alpha_{s,r}} \frac{x_s^t}{[\sum x_i^t] - x_k^t} \quad (1)$$

where PC is Percolation Centrality, which in the context of this research could indicate the value of the spread of knowledge at each node (player or knowledge); k represents a node; $\alpha_{s,r}$ represents the number of shortest paths between the source node s and the destination node r; x_k^t corresponds to the node percolation state at a given time t; and $\sum x_i^t$ represents the sum of the node percolation state represented by the variable x at a given time t. In other words, the higher the $PC^t(k)$, the greater the degree of knowledge spread of that node (e.g., PoC practitioner). The weight (state) linked to the percolation paths depends on the percolation levels signed for the originating nodes, based on the premise that the higher the percolation level of an originating node, the more important the originating paths of that node are.

For instance, taking Fig. 3 as an example, the dissemination of knowledge produced in the practice of Improvising (Network Y) to the practice of Describing could be questioned, if the source and destination nodes have equal levels of percolation (propagation), where the paths that connect them become insignificant for a possible transmission of knowledge. However, if the destination nodes have lower percolation levels, the knowledge produced by the practice of Improvising tends to percolate (propagate), i.e., the dissemination of knowledge is only disseminated if the nodes of origin are at higher levels compared to the destination nodes.

4.3. A Conceptual Example of Using Percolation Theory and Knowledge Networks in PoC

In the following, we aim to demonstrate two scenarios using a PoC practices context model (Neto et al., 2020b) supported by Knowledge Networks and Percolation Theory, particularly the Percolation Centrality model proposed by Piraveenan et al. (2013).

In both examples, during our immersion in the natural PoC habitat, we observed PoC practitioners forming knowledge networks, but in different practices (Fig. 7). Note that the percolation thresholds used in the percolation probability in both examples in this section are intended to be conceptual illustrations. That is, if we visualize a node (e.g., a player or practice) with a value of 0.2 (percolation state), it has higher probability to percolate (propagate) knowledge when compared to a node with a value of 0.1.

As can be seen in Fig. 7, we have 3 players (PoC practitioners) – Player 2, Player 4, and Player 6 generating a certain knowledge – Knowledge A, which has a probability of percolation=0.2 in the practice of Exploring with the following probabilities of percolation: (i) Player 2, probability of percolation=0.1; (ii) Player 4, probability of percolation=0.2; and (iii) Player 6, probability of percolation=0.2.

On the other side, the knowledge – Knowledge H generated by Players 9 and 7 has the following probabilities of percolation: (iv) Player 9, probability of percolation=0.5; and (v) Player 7, probability of percolation=0.5 in the practice of Improvising.

Considering that node Knowledge A has the largest number of players and connections, **we could deduce** (our emphasis) that the centrality of percolation would be higher than node Knowledge H, thus, having a higher influence on node Knowledge B.

However, calculating the Percolation Centrality based on Fig. 8, the PC of node Knowledge A, represented as *PC (ka)*, is 0.625 and the PC of node Knowledge H, represented as *PC (kh)*, is 0.667. In other words, even if node Knowledge A has a higher number of players and connections, the higher probability of percolation and potentially more influence on node Knowledge B is with node Knowledge H, which has a higher level of PC because it is connected to players with a higher level high of PC (Fig. 8).

In a different experiment, we observed and learned from our data analysis that if the PoC Knowledge Network has a different formation (Fig. 9), it can contribute with a higher or lower probability of percolation, thus influencing other nodes in the network. In other words, a different network formation with other players or players in different positions (i.e., different practices) can affect (positively or negatively) the production and dissemination of knowledge throughout the whole network.

As can be seen in Fig. 9, this PoC Knowledge Network has a different formation compared to Fig. 7. In this example, we have the players – Players 1, 9, and 7 generating some certain knowledge – Knowledge A with a probability of percolation=0.2 in the practice of Exploring with

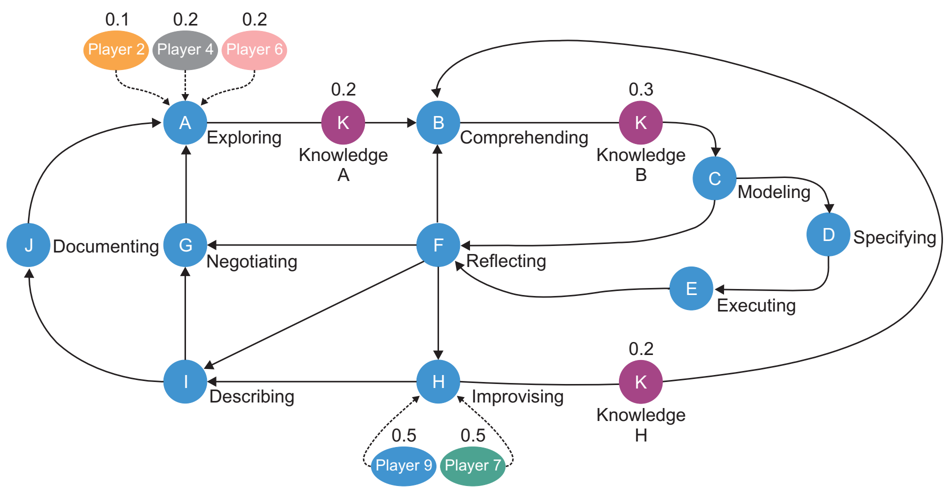

Fig. 7. Proof-of-Concept Knowledge Network – nodes and their probability (values) of percolation.

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the following probabilities of percolation: (i) Player 1, probability of percolation=0.3; (ii) Player 9, probability of percolation=0.5; and (iii) Player 7, probability of percolation=0.5.

On the other hand, the knowledge – Knowledge H generated by Players 4 and 5 has the following probabilities of percolation: (iv) Player 4, probability of percolation=0.1; and (v) Player 5, probability of percolation=0.1 in the practice of Improvising. Thus, calculating Percolation Centrality based on Fig. 9, the *PC* of node Knowledge A *(ka)* is 0.825 and the *PC* of node Knowledge H *(kh)* is 0.4. We understand that node Knowledge A has a higher level of *PC* as it is closer to players (PoC practitioners) with a higher percolation value and a greater probability to influence node Knowledge B (Fig. 10).

If we consider, in the case of Fig. 8, the addition of a new player (PoC practitioner) to the 'game' (e.g., PoC activity), there is a high probability of the establishment of a new network (alliance) of the new player towards another player, which increases the random acquisition of a new knowledge (new node) using node Knowledge H, which has a PC greater (0.677) than the PC of node Knowledge A (0.625), in this particular practice.

However, in the case of Fig. 10, the probability of acquiring knowledge increases in the use of node Knowledge A, which has a PC greater (0.825) than the PC of node Knowledge H (0.4), in this particular practice.

4.4. The Applicability of Knowledge Networks and Percolation Theory in the Context of PoC

While PoC is an activity that appears to be "purely technological," particularly in the domain of IT, its context is grounded in a complex network (or several networks) of sociotechnical phenomena (Neto et al., 2019). In other words, there are various "free and intuitive" movements carried out by its set of practitioners forming the core of

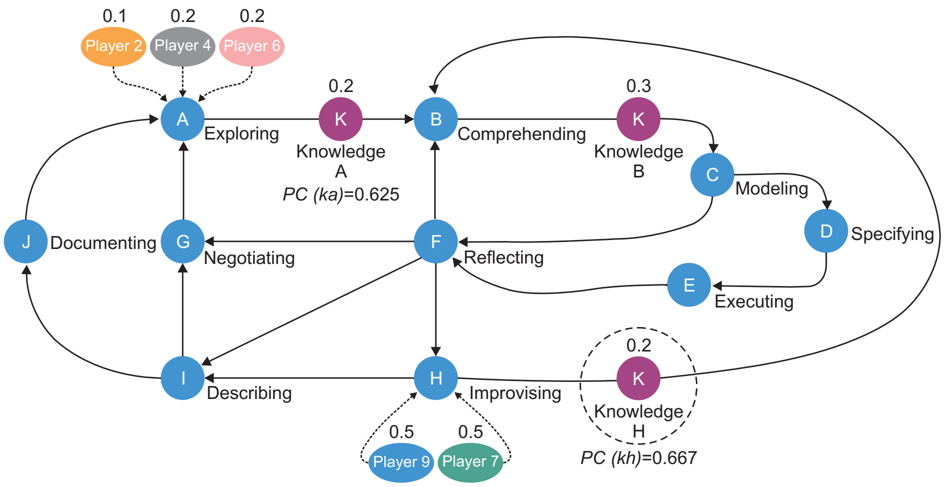

Fig. 8. Node Knowledge H has a higher *PC (kh)* – a higher probability to influence node Knowledge B.

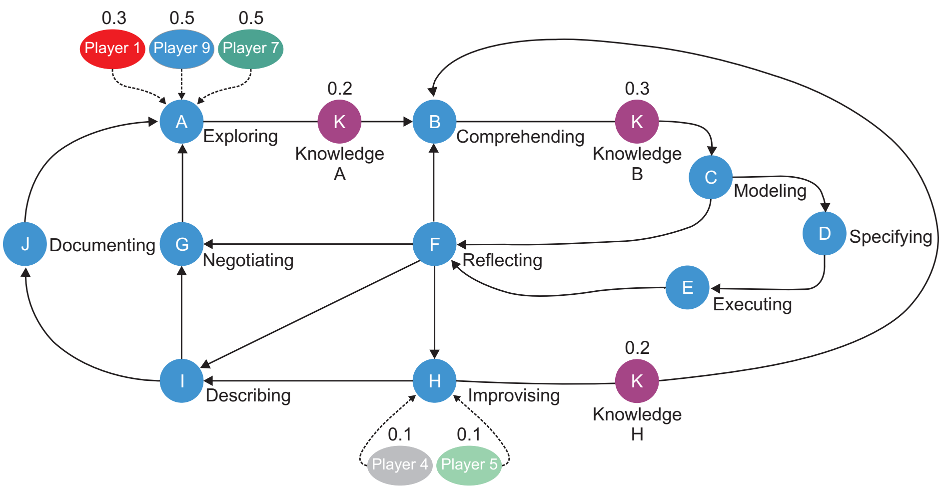

Fig. 9. Proof-of-Concept Knowledge Network – different players in the practice of Exploring and Improvising.

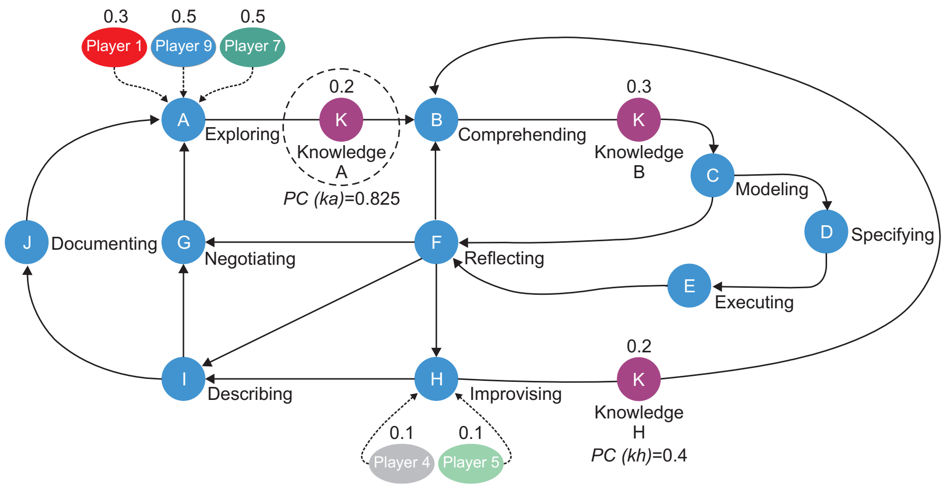

Fig. 10. Knowledge A has a higher *PC (ka)* – a higher probability of influencing Knowledge B.

these practices in the context of PoC, acting without a rationality and explicit catalog of activities and in constant cycles of collaboration with different actors (practitioners and several organizations) during development and execution of PoC.

Therefore, we learned that in the context of PoC it is **not always what it looks like or is imagined to be** (our emphasis), but rather "in theory there is no difference between theory and practice, while in practice there is" (Brewster, 1882, p. 202).

In this way, we envision that in the use of Practice Context Models 'linked' to Knowledge Networks and Percolation Centrality, there is a contribution to an analysis of the taxonomy among players (e.g., PoC practitioners, specialists, enthusiasts, researchers, teachers, etc.), certain knowledge (produced or consumed), and their research networks. With the adoption of this proposal each player has a model in the creation of alliances (knowledge networks) with different players (different PoC practitioners), in order to fulfill the 'game mission' (e.g., generation of scientific and technological knowledge in the context of PoC).

In other words, we envisage the use of "Practice Context Models linked to Knowledge Networks and Percolation Theory" as a potential (and feasible) proposal to be built through the attribution of values (weights) to the vertices (players, practices, competencies, movements, scenarios, and knowledge). This approach can allow the players (PoC practitioners) to have greater flexibility in building alliances with other players (new vertices), focusing on those with higher value (focus on quality) in collaboration networks (research networks). In other words, alliances (connections) aim to produce and make available knowledge in complex networks in the context of PoC, thus contributing to knowledge management in the context of PoC.

Hence, practitioners and organizations in the context of PoC could use this proposal to contribute to the definition of an evaluation model within practices in the context of PoC. In this way, the Practices Context Model could contribute to the analysis and documentation of the formation of those knowledge networks in PoC and with that establish their states, based on several and specific criteria and an evaluation defined by any organization, and with this they could contribute to the improvement of those practices in the context of the PoC, as well as the whole 'PoC practice.'

5. CONCLUSION AND FUTURE WORK

According to Borges (2006), the universe of scientific information is a universe of sharing – ideas, techniques, methodologies, **information**, and **knowledge** (our emphasis), a definition that we translated to and apply to a PoC practices context model. Therefore, we highlight a definition of a collaborative, interactive, and motivating model in the establishment and connection of different PoC practices between different practitioners and their organizations, which aims to develop and provide an innovative collaboration platform in a PoC context.

During our immersion in the natural PoC habitat, we discovered an interesting phenomenon with respect to the production of discourse and knowledge in the context of PoC being based on the relationship of the parts with the whole and vice versa or the mediators with their context, that is, elements that allow the production of meaning. In other words, we learned the production of meaning is grounded by the hermeneutic circle and based on the movements of interpretation and comprehension using the knowledge networks in the context of PoC, where during those movements of interpretation and understanding, practitioners and their activities create and promote knowledge, where that knowledge contributes to their own evolution, in addition to the production of new activities.

Also, we identify the development of several knowledge networks in the context of PoC, e.g., a network where two practitioners work together, through the practice of Comprehending, in search of more information about a particular artifact to be used in PoC (Fig. 3). Another example is a network composed of a set of practitioners seeking alternatives (Practice of Improvising) to replace a performance benchmark that was initially considered to be used in a PoC. Thus, we envisage PoC practitioners using the Practices Context Model associated with Knowledge Networks and Percolation Theory, aiming to encourage collaboration between different practitioners and promoting the construction of new knowledge networks in the context of PoC.

In other words, we see a greater likelihood of the development and improvement of PoC practices in order to contribute to the production and dissemination of knowledge, through a naturally collaborative and user-friendly platform, aiming to contribute to the systematization and evaluation of these networks. Moreover, the logic of the model could intelligently distribute the participating nodes (e.g., PoC practitioners) in their missions (PoC practices) in order to contribute so that the entire network can percolate (propagate) information and generate knowledge.

In this study, we have learned about the 'natural knowledge' in PoC that falls on a **spectrum of cognitive development spread throughout its network** (our emphasis), as each element (node) in the network produces and disseminates certain knowledge that flows to other elements (e.g., PoC practitioners, practices, other PoC activities, among others; see Fig. 3). Therefore, we present this study as a starting point of novel research into using Practice Context Models with the aim to contribute to knowledge management in PoC activities. We envision the "connection" with Knowledge Networks and Percolation Theory as a potential instrument to identify the network structure based on a percolation threshold and analyze the importance of the nodes (PoC practitioners, practices, competencies, movements, and PoC scenarios) during the percolation of knowledge in these networks in the context of PoC.

As the main objective in this study, we aimed to provide scenarios (Neto et al., 2019, 2020a, 2020b) grounded by a PoC practices context model of how the practitioners, practices, competencies, movements, and scenarios in the context of PoC could learn and then influence (and be influenced by) the percolation threshold. We understand that this would be useful for calculating a learning curve for each knowledge network in aiming to address a dynamic percolation model in each practice in the context of the PoC model, where a PoC practitioner can excel in one particular practice (e.g., Practice of Improvising), but be deficient in another practice (e.g., Practice of Documenting).

For future work, we intend to materialize this model in a software development prototype and propose methods on how to evaluate and classify the nodes in those PoC Knowledge Networks. Thus, we aim to advance our research in seeking possibilities regarding how to make dynamic predictions about future PoC developments and movements by their practitioners, i.e., how to distribute the players (PoC practitioners) in the knowledge networks, for example, players 1, 2, and 3 (PoC practitioners), aiming to provide a balance across the whole network and contribute to knowledge management over the entire network (practice) in the context of PoC.

CONFLICTS OF INTEREST

No potential conflict of interest relevant to this article was reported.

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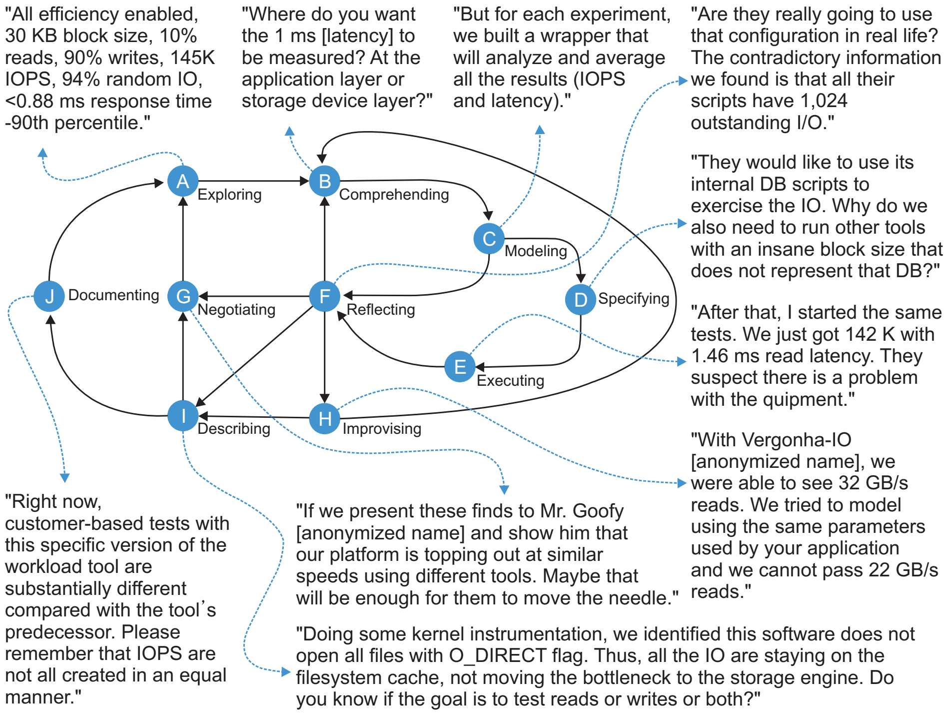
APPENDIX 1. Some examples of PoC scenarios



 https://doi.org/10.1633/JISTaP.2021.9.1.1

APPENDIX 2. Some examples of PoC sketches