Engineering Applications of Artificial Intelligence 71 (2018) 190–209

Contents lists available at ScienceDirect

Engineering Applications of Artificial Intelligence

journal homepage: www.elsevier.com/locate/engappai

Computational narrative mapping for the acquisition and representation of lessons learned knowledge

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ARTICLE INFO

Keywords:
Knowledge management
Lessons learned
Knowledge acquisition
Knowledge representation
Human learning
Computational narrative mapping

ABSTRACT

Lessons learned knowledge is traditionally gained from trial and error or narratives describing past experiences. Learning from narratives is the preferred option to transfer lessons learned knowledge. However, learners with insufficient prior knowledge often experience difficulties in grasping the right information from narratives. This paper introduces an approach that uses narrative maps to represent lessons learned knowledge to help learners understand narratives. Since narrative mapping is a time-consuming, labor-intensive and knowledge-intensive process, the proposed approach is supported by a computational narrative mapping (CNM) method to automate the process. CNM incorporates advanced technologies, such as computational linguistics and artificial intelligence (AI), to identify and extract critical narrative elements from an unstructured, text-based narrative and organize them into a structured narrative map representation. This research uses a case study conducted in the construction industry to evaluate CNM performance in comparison with existing paragraph and concept mapping approaches. Among the results, over 90% of respondents asserted that CNM enhanced their understanding of the lessons learned. CNM's performance in identifying and extracting narrative elements was evaluated through an experiment using real-life narratives from a reminiscence study. The experiment recorded a precision and recall rate of over 75%.

1. Introduction

Organizations must confront a range of uncertainties and challenges as the world becomes more complex and chaotic. As a result, companies have started to prepare themselves for these changes (Geissle and Krys, 2013). Decision-making, which mainly relies on human knowledge and experiences, is listed as one of the top 10 organizational challenges (McKinsey Quarterly, 2007). Lessons learned is a prevalent learning method for both individuals and organizations. According to the Center for Army Lessons Learned (CALL) of the United States Army Combined Arms Center (2009), lessons learned is defined as approved knowledge and experiences that induce individuals to reflect on their actions.

The National Aeronautics and Space Administration (NASA) expresses the view that the lessons learned can trigger a significant positive response, reinforcing the good aspects and experiences gained from previous lessons (2002). Weber et al. (2001) supported the idea that positive improvement will occur after the lessons learned process. Lessons learned indeed make use of organizational memory or experience to foster understanding and learning. Through hands-on practice, original thoughts or mental models have been deeply changed. Traditionally, people gain lessons learned in two ways: trial and error and learning from past experiences. The first approach mainly depends on the learners' capability, while the second approach relies on the knowledge shared by experts or knowledge workers. In the first approach, individuals may have to first suffer severe consequences through trial and error, such as financial loss or injuries, before learning occurs. This is usually not the case in the second approach.

Executives have started to face challenges induced by the retirement of the baby boomers (Rupčić, 2017; American Productivity and Quality Center [APQC], 2008; Toossi, 2004). Since most organizations conducted a massive recruitment of baby boomers during the 1970s and

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https://doi.org/10.1016/j.engappai.2018.02.011
Received 5 January 2017; Received in revised form 11 January 2018; Accepted 19 February 2018

1980s, a retirement tsunami began in 2015 (Angeloni and Borgonovi, 2016). This trend is expected to last for 10 to 15 years (Joe et al., 2013). Around 21 percent of the U.S. working population, are retired in 2014. It is expected to increase to 24.8% by 2024 (Toossi, 2015). This situation is prevalent in other developed countries as well. As large numbers of highly skilled and experienced employees leave their workplaces, opportunities for learning from past experiences are fast diminishing (Sumbal et al., 2017). The critical knowledge and invaluable experience of skilled employees will soon disappear, and opportunities to gain lessons learned from past experiences will be limited. Since knowledge gained from past experiences and lessons learned in organizations is an invaluable asset for enterprises (Bonjour et al., 2014; Sharma and Bhattacharya, 2013), there is an urgent need to retain this knowledge and help employees acquire lessons learned from past experiences.

Narratives exist in the human world in an infinite diversity of forms. Researchers agree that the real-world narratives shared by experts and knowledge workers are helpful in educating novices to learn new knowledge and skills (Lawrence and Paige, 2016; Burke and Kass, 1995). A narrative helps to retain human memory, especially cultural memories of the past. Apart from retaining knowledge and wisdom, narratives are useful tools for humans to recall and share knowledge during their lifespans (Burnett et al., 2015; Bluck and Glück, 2004). A narrative is an important means to represent and transfer lessons learned to novices (Lawrence and Paige, 2016; Tappan and Brown, 1989). Geiger and Schreyögg (2012) argue that narratives aid in knowledge retention, sharing and problem solving. However, the narratives that store invaluable knowledge and experience are often embedded in the minds of knowledge workers or organizational documents, such as reviews, reports and guidebooks (Štajner and Mladenić, 2009; Spender, 1996). Traditionally, knowledge workers need to work with their mentors for a certain period or review previous organizational documents to gain lessons learned about the organization (Maruta, 2014). This process can be lengthy, and moreover, workers may not gain the correct lessons learned when they review organizational documents.

Studies have shown that using a narrative map can improve reading comprehension among skilled readers, less skilled readers and readers with learning disabilities (Derefinko et al., 2014; Idol, 1987). A narrative map is regarded as an effective tool to help learners understand narratives (Stringfield et al., 2011; Burke, 2004). Therefore, this study attempts to investigate human learning processes for lessons learned in order to develop an approach to foster quality learning from narrative texts. In addition, it proposes a systematic narrative mapping method to construct narrative maps for acquiring and representing lessons learned knowledge. Since manual narrative mapping is inconsistent, time-consuming, labor-intensive and knowledge-intensive, this paper aims to develop a computational method to automatically conduct narrative mapping and generate narrative maps.

This paper makes the following contributions: (1) A narrative mapping method is developed to represent lessons learned knowledge and help learners better understand narratives of past experiences; and (2) A computational narrative mapping (CNM) method is developed to automate the proposed narrative mapping and facilitate the narrative map construction process. Two algorithms in CNM have been designed and developed to automatically convert narrative texts into narrative maps. The resulting narrative maps have a simple and concise structure that can facilitate lessons learned. A case study and an experiment-based evaluation are conducted to measure the performance of the proposed solution.

The rest of the paper is structured as follows. The relevant literature is analyzed in Section 2. The proposed methodology is introduced in Section 3. Section 4 describes the evaluation methods, including a case study and an experiment, while Section 5 discusses the results of the evaluations. Section 6 concludes the paper and provides ideas for future work.

2. Relevant literature

This section reviews research on human learning using lessons learned and narratives, as well as current approaches for constructing lessons learned systems and narrative databases. Narrative mapping and other computational approaches are discussed to aid in the design and development of a novel narrative mapping method for the acquisition and representation of lessons learned knowledge.

2.1. Human learning related to lessons learned and texts

Experience plays an important role in the learning process in the experiential learning model (Phelps et al., 2016; Coffield et al., 2004; Kolb, 1984), demonstrating a significant correlation with the trial-and-error approach of lessons learned. In the view of Kolb (1984), experiential learning is defined as a process to group and understand experience, and then transform this experience to knowledge. It is similar in nature to lessons learned, as both emphasize that knowledge is gained through experience (Coffield et al., 2004; Kolb, 1984). However, individuals may repeat certain mistakes and suffer severe consequences when they misunderstand or neglect the lessons learned.

Researchers have advocated the use of real-world narratives shared by experts and knowledge workers to help in educating novices to learn new knowledge and skills (Lawrence and Paige, 2016; Burke and Kass, 1995). Through reading texts, humans can construct coherent situations models related to the texts. Coherent situations models are regarded as the mental representation of a text after readers have associated it with their previous knowledge and experience (Kirby and Lawson, 2012). However, different people can interpret the same text in different ways. One of the challenges is the reader's competence in understanding the text. If readers have difficulties understanding the text, they may not derive the correct messages from it. If the human brain mainly focuses on understanding the texts, they allocate less processing power and storage capacity to making inferences simultaneously. Hence, poor mental representations are constructed, which then lowers the long-term retention of information (Engle and Conway, 1998). Apart from this, if people have limited experience and prior knowledge, they may not be able to construct correct mental representations (Vosniadou and Brewer, 1992). Therefore, it is important to develop a method that can provide a simple and concise text structure for learners to understand narrative texts.

2.2. Lessons learned systems and narrative databases

With the development of information technology (IT), researchers have employed computational approaches to transfer lessons learned knowledge. NASA (2002) has adopted a lessons learned system to retain and disseminate valuable lessons regarding space development programs and projects. Information about a given lesson, such as an event that occurred, the lessons learned from dealing with the event and recommendations for future situations, is recorded. The lessons learned system and its content are organized by domain experts. The new lesson must be reviewed, approved and indexed by domain experts before being added to the system. The lessons learned system can send automatic notifications to users and support them in retrieving valuable experiential lessons through active searching.

Ferrada et al. (2016) highlighted that some of the main challenges faced by construction companies in transferring lessons learned knowledge are the absence of a systematic approach and a lack of organizational learning culture. It is also reported that current lessons learned systems adopt web-based platforms with searchable functions for users to retrieve valuable experiential lessons. However, current lessons learned systems are not widely accessed by users. Ferrada et al. (2016) proposed a mobile-based platform that would incorporate information and communication technologies, cloud computing and knowledge management approaches to retain and disseminate valuable