Chapter 14

A Framework for Human–Technology Social Systems: The Role of Inter-Personal Interactions

Monika Lohani  
University of Utah, USA

Eric G. Poitras  
University of Utah, USA

Charlene Stokes  
The MITRE Corporation, USA

ABSTRACT

Advancements in semi- and fully-autonomous systems have made human-technology interaction a dynamic and social process. In this chapter, the authors highlight the importance of interpersonal interactions between human and technology and how they can be modeled, tracked, and fostered in the context of adaptive instructional systems. They will first introduce a human-technology social systems framework, which integrates individual factors (human and technology), situational factors (e.g., stress), and team interaction-relevant factors (e.g., communication and team cognition) that contribute to various team-related outcomes (e.g., learning and performance). Using examples from interactive virtual agents and educational technology, they discuss attributes of technology that should be considered to optimize joint learning and performance in applied contexts. The proposed framework points to novel research directions and is likely to offer an understanding of mechanisms that could enhance learning opportunities in diverse socioemotional contexts.

INTRODUCTION

Technological advancements in semi and fully-autonomous machines have created an opportunity for humans and technology to work dynamically as teammates in complex and high-stakes environments, making it essential to identify factors that can optimize human-technology interaction for better perfor-
mance and learning outcomes. In this chapter, we focus on the importance of interpersonal interactions between human and technology, which may be conceptualized in terms of several measurable components grounded in accounts of information processing and other contemporary approaches, as defined in the proposed framework of human-technology social systems. The main contributions of this chapter can be summarized as follows: First, we present a framework that integrates individual and human-technology interaction related processes that may impact their functioning together. We focus on the importance of fostering critical non-technical factors, namely, a set of cognitive, social, and emotional abilities that promote human-technology interaction. Next, as preliminary supporting evidence, a case study is presented that examined the impact of facilitating non-technical skills while experienced military intelligence analysts work with a virtual agent technology as a team in a real-world environment. This case study (based on focus groups) provides a proof-of-concept of our framework and shows how non-technical skills can be developed and evaluated during human and technology interactions in applied contexts. Finally, we discuss application of this framework to an enhanced technology and socio-emotional learning context, where optimizing human-technology interaction may improve academic and social life outcomes. The broader implication of this work is that interpersonal abilities outlined in the proposed framework can be tracked, modeled, and fostered in the context of adaptive instructional systems.

AN OVERVIEW OF THE HUMAN-TECHNOLOGY SOCIAL SYSTEMS FRAMEWORK

Human-technology interactions are dynamic and complex. With everyday interactive technologies on the rise, it has become increasingly important to understand how human-technology relationships can be shaped to improve effective use of technology through an integration of technical and non-technical factors. We define technical factors as task-relevant abilities and non-technical factors as cognitive, social, and emotional abilities that are crucial for successful interactions with humans (Anderson, Jensen, Lippert, & Østergaard, 2010; Buljac-Samardzic, Dekker-van Doorn, van Wijngaarden, & van Wijk, 2010; Flin and Maran 2004; Mathieu, Maynard, Rapp, & Gilson, 2008; Salas et al., 2008). A lack of consideration of non-technical factors can lead to poor performance, accidents, and error (Flin, Glavin, & Patey, 2003; Hancock et al., 2011; Schaefer et al., 2016). While much progress has been made in building technical capabilities in technologies, development of non-technical skills is still in its infancy. Little is known about how non-technical skills could be effectively embedded in technology. Seminal work on interpersonal intelligence can inform a way to embed non-technical skills in technology. Interpersonal intelligence is an ability to understand, interact, and relate to other people (Gardner, 1983; Gardner & Moran, 2006). It is considered essential for social functioning, including working with others to meet shared goals (e.g., Connell, Sheridan, & Garner, 2004). Lessons learned from interpersonal intelligence can inform and build non-technical capabilities in human-technology interactions, as we discuss further.

While trying to develop interactive technology, several elements could be considered including team dynamics (Cannon-Bowers, Salas, Tannenbaum, & Mathieu, 1995; Cooke, Gorman, & Winner, 2007; Hinds & Weisband, 2003; Kozlowski & Ilgen, 2006; Salas, Cooke, & Rosen, 2008; Salas, Dickinson, Converse, & Tannenbaum, 1992), coordination (Shah, 2011), communication (Harbers, Jonker, & Riemsdijk, 2012), rapport (Gratch et al., 2007), cognitive-affective processes (Breazeal, 2004; Lisetti