

Chapter 39

Computer Agent Technologies in Collaborative Assessments

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ABSTRACT

Often in our daily lives we learn and work in groups. In recognition of the importance of collaborative and problem solving skills, educators are realizing the need for effective and scalable learning and assessment solutions to promote the skillset in educational systems. In the settings of a comprehensive collaborative problem solving assessment, each student should be matched with various types of group members and must apply the skills in varied contexts and tasks. One solution to these assessment demands is to use computer-based (virtual) agents to serve as the collaborators in the interactions with students. The chapter presents the premises and challenges in the use of computer agents in the assessment of collaborative problem solving. Directions for future research are discussed in terms of their implications to large-scale assessment programs.

INTRODUCTION

Collaborative problem solving is recognized as a core competency for college and career readiness. Students emerging from schools into the workforce and public life will be expected to work in teams, cooperate with others, and resolve conflicts in order to solve the kinds of problems required in modern economies. They will further need to be able to use these skills flexibly with various group compositions and environments (Davey, et al., 2015; Griffin, Care, & McGaw, 2012; O'Neil, & Chuang, 2008; Rosen, & Rimor, 2013; Roseth, et al., 2006). Educational programs in K-12 have focused to a greater extent on the advancement of learning and the assessment of collaborative problem solving as a central construct in theoretical and technological developments in educational research (National Research Council, 2011, 2013; OECD, 2013a; National Assessment Governing Board, 2013; U.S. Department of Education, 2010). Collaborative skills are included within the major practices in the 2014 U.S. National

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Assessment of Educational Progress (NAEP) Technology and Engineering Literacy (National Assessment Governing Board, 2013). In NAEP Technology and Engineering Literacy assessment program, students are expected to show their ability in collaborating effectively with computer-based (virtual) peers and experts and to use appropriate information and communication technologies to collaborate with others on the creation and modification of knowledge products. Similarly, the Israeli national program of adopting the educational system to the 21st century illustrates a multi-year program with the goal of leading the implementation of innovative pedagogy and assessment in schools, including collaboration, communication, and problem solving (Israel Ministry of Education, 2011). Collaborative problem solving is one of the areas that the Organisation for Economic Co-operation and Development (OECD) emphasized for major development in the Programme for International Student Assessment (PISA) in addition to scientific, math, and reading literacy for the 2015 assessment. Collaborative problem solving refers to problem solving activities that involve collaboration among a group of individuals (O'Neil, Chuang, & Baker, 2010; Zhang, 1998). In the PISA 2015 Framework (OECD, 2013b), collaborative problem solving competency is defined as "the capacity of an individual to effectively engage in a process whereby two or more agents attempt to solve a problem by sharing the understanding and effort required to come to a solution and pooling their knowledge, skills, and efforts to reach that solution" (p. 6). This definition treats the competency as conjoint dimension collaboration skills and the skills needed to solve a problem. For the PISA assessment, the focus is on individual capacities within collaborative situations. Thus, the effectiveness of collaborative problem solving depends on the ability of group members to collaborate and to prioritize the success of the group over individual successes. At the same time, this ability is still a trait in each of the individual members of the group. Development of a standardized computer-based assessment of collaborative problem solving skills, specifically for large-scale assessment programs, remains challenging. Unlike some other skills, collaborative problem solving typically requires using complex performance tasks, grounded in varied educational domains, with interaction among students. These factors can affect the level of control that can be applied to ensure accurate assessment of students.

In our chapter, an operational definition of collaborative problem solving refers to "the capacity of an individual to effectively engage in a group process whereby two or more agents attempt to solve a problem by sharing knowledge and understanding, organizing the group work and monitoring the progress, taking actions to solve the problem, and providing constructive feedback to group members." First, collaborative problem solving requires students to be able to *establish, and maintain the shared understanding* throughout the problem-solving task by responding to requests for information, sending important information to agents about tasks completed, establishing or negotiating shared meanings, verifying what each other knows, and taking actions to repair deficits in shared knowledge. Shared understanding can be viewed as an effect, if the goal is that a group builds the common ground necessary to perform well together, or as a process by which peers perform conceptual change (Dillenbourg, 1999). Collaborative problem solving is a coordinated joint dynamic process that requires periodic communication between group members. Communication is a primary means of constructing a shared understanding or Common Ground (e.g., Clark, 1996; Nelson, 1999). An "optimal collaborative effort" is required of all of the participants in order to achieve adequate performance in a collaborative environment (Dillenbourg, & Traum, 2006). Second, collaboration requires the capability to identify the type of activities that are needed to *solve the problem* and to follow the appropriate steps to achieve a solution (Mayer, & Wittrock, 1996; Roschelle, & Teasley, 1995). This process involves exploring and interacting with the problem situation. It includes understanding both the information initially presented in the problem and any information that is uncovered during interactions with the problem. The accumulated

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