Computer Agent Technologies in Collaborative Learning and Assessment

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INTRODUCTION

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 and describes how human and computer agent collaborative assessments are used in international learning and assessment project Animalia.

BACKGROUND

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 (Care, & Griffin, 2014; Griffin, Care, & McGaw, 2012; O'Neil, & Chuang, 2008; Rosen, & Rimor, 2012). Educational programs 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). Collaborative skills are included within the major practices in the 2014 U.S. National Assessment of Educational Progress (NAEP) Technology and Engineering Literacy (National Assessment Governing Board, 2013). In this 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 this 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."

COMPUTER AGENT TECHNOLOGIES

Collaboration can take many forms, ranging from two individuals to large teams with predefined roles. For assessment purposes, collaboration can also be performed using simulated agents playing the role of team members, using computer or humans as team members. Thus, a critical distinction is whether all team members are human or some are computer agents. There are advantages and limita-

tions for each method, which are outlined below. The Human-to-Human (H-H) approach provides an authentic human-human interaction that is a highly familiar situation for students. Students may be more engaged and motivated to collaborate with their peers. Additionally, the H-H situation is closer to the collaborative problem solving situations students will encounter in their personal, educational, professional, and civic activities. However, because each human will act independently, the approach can be problematic because of individual differences that can significantly affect the collaborative problem solving process and its outcome. Therefore, the H-H assessment approach of collaborative problem solving may not provide sufficient opportunity to cover variations in group composition, diversity of perspectives, and different team member characteristics in a controlled manner for accurate assessment of the skills on an individual level. Also, computer agent technology can contribute to efficiency in data collection by dramatically decreasing the assessment time with strategic dialogue management and rapid immersion in the collaborative context. Simulated team members using a preprogrammed profile, actions, and communication can potentially provide the coverage of the full range of collaboration skills with sufficient control. In the Human-to-Agent (H-A) approach, collaborative problem solving skills are measured by pairing each individual student with a computer agent or agents that can be programmed to act as team members with varying characteristics relevant to different collaborative problem solving situations. Group processes are often different depending on the task and could even be competitive. Use of computer agents provides a component of non-competitiveness to the collaborative problem solving situation, as it is experienced by a student. Additionally, if the time-on-task is limited, time spent establishing common ground or discussing non-task relevant work may lower group productivity. As a result of these perceived constraints, a student collaborating in H-H mode may limit significantly the extent to which collaborative problem solving dimensions,

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