Chapter 13
A Tough Nut to Crack:
Measuring Collaborative Problem Solving

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ABSTRACT

The purpose of our project is to explore the measurement of cognitive skills in the domain of science through collaborative problem solving tasks, measure the collaborative skills, and gauge the potential feasibility of using game-like environments with avatar representation for the purposes of assessing the relevant skills. We are comparing students' performance in two conditions. In one condition, students work individually with two virtual agents in a game-like task. In the second condition, dyads of students work collaboratively with two virtual agents in the similar game-like task through a chat box. Our research is motivated by the distributed nature of cognition, extant research on computer-supported collaborative learning (CSCL) which has shown great value of collaborative activities for learning, and the framework for the Programme for International Student Assessment (PISA) framework. This chapter focuses on the development and implementation of a conceptual model to measure individuals' cognitive and social skills through collaborative activities.

INTRODUCTION

Emerging conceptions of learning reveal that learning is not only a cognitive, but also a social and constructive process (Salomon & Perkins, 1998). Cognitive and social approaches to science learning have highlighted the importance of discussion for helping students solve problems and achieve understanding. As a result, there is an urgent call for assessments to measure individual skills in collaborative settings. The field of computer-supported collaborative learning (CSCL) research deals with issues concerning collaboration, learning processes, and the use of

DOI: 10.4018/978-1-4666-9441-5.ch013

computers by providing a technology-enhanced environment where students work on group tasks and produce a collective product or response, but the assessment component does not account for the rich interactions among the team members when evaluating students' problem solving skills. In other words, most CSCL research focuses on exploring the important impact of collaboration on learning, however there is little research on how to fuse the quality of the process of collaborative problem solving with the outcome of problem solving in assessment. The purpose of our project is to explore the measurement of cognitive skills in the domain of science through collaborative problem solving tasks, measure the collaborative skills, and gauge the potential feasibility of using game-like environments with avatar representation for the purposes of assessing the relevant skills. In other words, our research examines whether the nature and quality of students' collaboration affects their cognitive understanding of scientific phenomena and their ability to solve meaningful science problems. We are comparing students' performance in two conditions. In one condition, students work individually with two virtual agents in a game-like task. In the second condition, dyads of students work collaboratively with two virtual agents in the similar game-like task through a chat box. Our research is motivated by the distributed nature of cognition and extant CSCL research which has shown great value of collaborative activities for learning and by the Programme for International Student Assessment (*PISA*) framework for collaboration (Collaborative Problem Solving Framework, Graesser & Foltz, 2013). This chapter focuses on the development and implementation of a conceptual model to measure individuals' cognitive and social skills through collaborative activities. The overall hypothesis of the study is that providing collaboration opportunities may promote greater integration of knowledge, thus result in better student performances in an assessment.

COLLABORATIVE PROBLEM SOLVING SKILLS FRAMEWORK

Collaborative Interactions and Cognition

Collaborative learning techniques have been used extensively by educators at all levels as research suggests that active student participation in the small-group interactions is critical to effective learning (Chinn, O'Donnell, & Jinks, 2000). The CSCL research in educational settings has not become prominent until somewhat more recently, and this has been partially intertwined with the widespread use of educational technology in the classroom (see Hmelo-Silver, Chinn, Chan, & O'Donnell, 2013). Within the domain of educational assessment, there has been a strong recent interest in the evaluation of CPS as a social skill (Griffin, Care, & McGaw, 2012; Organization for Economic Co-operation and Development [OECD], 2013; von Davier & Halpin, 2013). However, social skills are not sufficient to define CPS, which also includes other essential components identified by collaborative learning research as key to knowledge construction such as establishing shared goals, accommodation of alternative perspectives to converge ideas, and regulative attempts to achieve goals. In our CPS assessment design, we realize the importance of measuring both the social and cognitive aspects of knowledge and skills that affect student performance when taking an assessment in a collaborative setting.

A key question that has driven CSCL research is: How do learners develop shared understanding of the task to be accomplished, a question related to the process of knowledge co-construction. Knowledge co-construction, sometimes called shared cognition (Hatano & Inagaki, 1991; Wertsch, 1991) or convergent conceptual change (Roschelle, 1996) or the construction of joint problem space (Hmelo-Silver, Nagarajan, & Day, 2000; Roschelle, 1996), refers to the shared representation