Effects of Task Design on Collaboration Patterns in an Online Task

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Abstract: Collaborative problem solving (CPS) competency has become increasingly important which has led to an increase in developing CPS tasks for assessment purposes. The design of CPS tasks is critical, as design decisions can influence the opportunities individuals have to display targeted CPS behaviors. In this study, we describe how item characteristics from an online mathematics task relate to the nature of CPS interaction among teammates.

Introduction

In many contexts across school, the workplace, and the military there is increasing emphasis on problems that require individuals with differing viewpoints to find collaborative solutions, as many of the tasks that arise in our modern society are too complex for one person to solve alone. This has increased the need for collaborative activities to be incorporated into classrooms and assessments of collaborative problem solving (CPS) to be developed to better prepare students for the challenges of today's world (Fiore et al., 2018; Graesser et al., 2018). The design of such activities is important, as certain kinds of task characteristics may provide differences in opportunities for students to display targeted collaborative behaviors (Andrews et al., 2017). In this paper, we describe an online mathematics task that is designed to elicit CPS behaviors for assessment purposes. We seek to explore the nature of interactions among team members during task engagement and the extent to which certain item characteristics might elicit particular interaction patterns.

Methods

Participants in the study consisted of 48 7th, 8th, and 9th grade students (33 females, 15 males) at a middle school and high school in the northeastern U.S. During the study, participants first individually completed a battery of surveys (e.g., demographics questionnaire, content knowledge pre-test), were next assembled into 24 dyads to complete an online task on linear functions and mathematical argumentation, and then individually completed post-task surveys (e.g., content knowledge post-test, CPS Inventory). In the task, called the T-Shirt Math Task, students were presented with a problem in which a school student council was planning to sell t-shirts to their class and was considering three different companies for making the purchase. Students moved through a series of screens in the task to complete activities (e.g., develop cost equations for each company) to help determine which company may be the most appropriate choice. The task comprised 10 items, three constructed response, four dropdown, and three multiple-choice items (see Figure 1). To complete the task, students worked on their own separate computers that shared the same task screen via video conference. Both students in each dyad could control the cursor and type answer choices, and audio and video of their interactions were captured for analysis.

Video data were coded for the presence of five interaction patterns, with each of the 10 task items for each dyad characterized as reflecting one pattern (Kappa = .87). The *collaborative* interaction pattern involves each teammate working jointly on the task and equally sharing ideas. The *cooperative* interaction pattern is characterized by a division of labor and little engagement with each other's contributions. The *dominant/dominant* interaction pattern is characterized by an unwillingness by teammates to listen to and engage with other's contributions in a way that contributes to conflict. The *dominant/passive* interaction pattern is characterized by one teammate taking control of the task and another maintaining a subservient role. The *expert/novice* interaction pattern is characterized by a more knowledgeable teammate contributing more to the task, but actively inviting contributions from the less knowledgeable teammate (Tan et al., 2010).

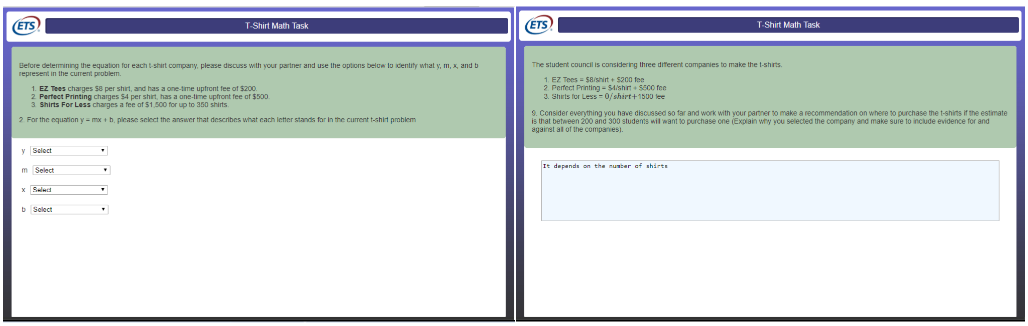

Figure 1. Screenshots of dropdown (left) and constructed response (right) items in T-Shirt Math Task.

Findings

Of the 235 interactions coded, we found that the cooperative interaction pattern was the most frequently observed pattern (50.6%) followed by the collaborative interaction pattern (29.7%), dominant/passive interaction pattern (18.7%), dominant/dominant pattern (0.4%), and expert/novice pattern (0.4%). Note that some dyads did not complete every task item. The latter two patterns were excluded from further analyses due to the low counts. We first examined whether there was a relationship between display of interaction patterns and the item type, specifically whether the item was a dropdown item, multiple-choice item, or a constructed response item. Results showed no significant association between pattern and item type, X^2 (4, N = 233) = 6.14, p = .19. We next examined whether display of interaction patterns would be associated with item difficulty which was operationalized according to mean item accuracy across the sample (items ≤ 50% correct were categorized as difficult). The relationship between interaction patterns and item difficulty was significant, X^2 (2, N = 233) = 18.73, $p < .001$. Specifically, there were more instances of the collaborative interaction pattern shown for difficult (80%) relative to easier (20%) items ($p < .001$), and in contrast, there were more instances of the cooperative interaction pattern shown for easier (51%) relative to difficult (49%) items ($p = .001$). The difference between display of the dominant/passive pattern for difficult (52%) and easier (48%) items was not significant ($p = .33$).

Discussion and future work

The results of the current study shed light on how certain item characteristics can relate to how individuals interact in collaborative tasks. We found that students were more likely to behave according to a collaborative interaction pattern when task items were more difficult while students were more likely to behave according to the cooperative interaction pattern when task items were easier. When assessing CPS skills, the collaborative interaction pattern is characterized by the variety of desired behaviors that contribute to effective performance (Andrews-Todd & Forsyth, 2018). Prior work has further shown that students perform better in groups (relative to working alone) when engaging in more complex tasks (Kirschner et al., 2011) signaling the potential need to design complex and challenging items and tasks when creating tasks for assessment of CPS. In ongoing work, we are exploring how the nature of students' interactions may differ when working on items in a different kind of task, specifically an educational game called Physics Playground (Shute et al., 2013). In our presentation, we intend to provide further comparisons between how the same teams of students interact in Physics Playground relative to the T-Shirt Math Task in an effort to continue exploration into how task design characteristics may relate to how individuals interact.

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Acknowledgments

This research was supported by the Institute of Education Sciences, U.S. Department of Education, through Grant R305A170432 awarded to Educational Testing Service (PI: Jessica Andrews-Todd). The opinions expressed are those of the authors and do not represent views of the Institute or the U.S. Department of Education.