"Sorry if I'm Leaving You in the Dust": Toward Understanding the Importance of Student Goals in Collaborative Problem Solving

Mehmet Celepkolu, University of Florida, mckolu@ufl.edu
Kristy Elizabeth Boyer, University of Florida, keboyer@ufl.edu

Abstract: This study reports on a study of the influence of students' *goal*—speed versus mastery—as they solve a computer science problem collaboratively. We conducted a study with 254 university students enrolled in introductory computer science, pairing based on the goal they reported for that day. Results with a comparison condition show that matching by goal may not benefit student learning unless other factors are also considered. However, for students who hold a mastery goal, pairing with another student who shares that goal may significantly improve the learning experience. These results advance our understanding of how we might adapt collaborative learning practices based on students' goals.

Introduction

Collaborative learning has long been shown to promote effective learning through exposing students with various perspectives on problem solutions, and fostering critical thinking through interaction (Lin, 2015). For computer science learning in particular, the collaborative paradigm of *pair programming* is a widely used collaboration strategy, and has shown significant advantages over solo (individual) programming approaches including an increase code quality, and student confidence. In pair programming, two learners collaborate on the same code and take turns in typing at the computer (the *driver*) and examining the code, helping to plan and catch errors (the *navigator*). Challenges observed within collaborative learning across many domains—such as conflicts between partners (Weinberger et al., 2010) or inequity arising within the discussion (Engle, Langer-Osuna, & McKinney de Royston, 2014)—have also been documented in pair programming. In particularly, when students hold different goals for an activity, such as whether to finish quickly or whether to spend as much time as needed to master the material, inequitable dynamics can emerge (Lewis & Shah, 2015). Agreeing upon a shared *goal* is an important component to the success of collaborative learning (Barron, 2003).

This paper presents a study of the impact of pairing students based on their goals during collaborative computer science learning that investigate the following question: *What is the impact of pairing students based on their goal (speed vs. mastery) for a collaborative computer science assignment?* The results shed light on how we may more effectively scaffold collaborative learning, particularly for students who hold a *mastery* goal for that activity.

Methods

We conducted a two-condition exploratory study to investigate the effects of pairing students based on their goal—speed versus mastery—for a particular learning activity. The study was conducted with students who were actively enrolled in a Programming Fundamentals computer science course at a large public university in the southeastern United States. Out of the 278 consenting students, 254 students were present on the day that the research study was conducted. After students completed the lab assignment and a posttest and post-survey, they were free to leave. The course required all students to attend labs and complete the lab assignments even if they did not consent to participate this research study. The basis of the weekly lab was a learning task that reinforced concepts covered in the lecture over the preceding week. The programming task for this lab week was to implement a fictional game called "Hexbowling" in the Java programming language. Students across all 18 labs completed the same learning task. Each of the lab classes was randomly assigned into one of two conditions. Nine labs were assigned to the *Goal-Matched* condition, in which students were matched based on whether they reported a mastery goal or a speed goal. In this condition, because student goal would be made public to other students through matching, students were shown a short video emphasizing that many factors and constraints influence a person's goal on a given day and one goal is not considered "better" than the other. Then students indicated their goals for that day on a small index card and were paired by goal by their teaching assistant. In the comparison condition (the *Randomly-Matched* condition), students completed the same index card but were randomly paired and were not made aware of each other's preference. After completing the task, students completed a posttest consisting of seven multiple choice questions on the concepts from the lab. Students also completed a post-survey reporting on their learning experience, including one item that asked students to rate whether they would like to work with the same partner again, with choices of Yes, Maybe, and No.

Findings

First, we performed a top-level analysis comparing the two different conditions, *Goal-Matched* and *Randomly-Matched*, based on posttest score. Students in the *Goal-Matched* condition had a lower mean posttest score of 3.87 (n=112, *sdev*=1.52) than students in the *Randomly-Matched* condition had a posttest score of 4.41 (n=142, *sdev*=1.33). This difference is significant (t(252)=2.96, p=0.003, Cohen's d=0.38). With this result in hand, we looked more deeply at the students in each condition based on goal preference (Speed versus Mastery). We conducted a two-factor ANOVA to examine this possible interaction with respect to the outcome of posttest score. The main effect of Condition shows that students in the *Randomly-Matched* condition performed significantly better than students in the *Goal-Matched* condition (F(1, 250)=11.89, p=0.001, *partial eta*=0.045). The main effect of Goal reveals that students with the Speed goal achieved significantly higher posttest scores than students with the Mastery goal (F(1, 250)=4.73, p=0.03, *partial eta*=.019). The two-factor interaction term of Condition*Goal was not significant (F(1, 250)=2.33, p=0.19, *partial eta*=0.009).

After examining the posttest scores, we compared students' satisfaction level as measured by a post-survey item asking whether they would want to work with the same partner again. Once again using Condition and Goal as factors, we conducted a two-way ANOVA for satisfaction, which showed no main effect of Condition (F(1,250)=0.863, p=0.35, *partial eta* = .003) and no main effect of Goal (F(1,250)=1.886, p=1.171, partial eta = 0.007). However, the model revealed a two-way interaction of Condition and Goal (F(1,250)=8.368, p=0.004, *partial eta* = 0.032). Students with the Mastery goal indicated significantly greater satisfaction in the *Goal-Matched* condition than in the *Randomly-Matched* condition.

Overwhelmingly, students report willingness to work with the same partner again. This bias toward positivity is common among peers, and it means that a response of "No" is particularly noteworthy. Students with a Mastery goal gave more negative ratings in the *Randomly-Matched* condition (15.28% negative) than the *Goal-Matched* condition (4.35% negative).

Conclusion

Collaborative learning is increasingly essential for today's complex problem solving. However, the success of collaborative learning depends on many factors. The goal of the study reported here has been to examine whether matching students by their goal—speed versus mastery—for a particular learning activity was beneficial to their learning and satisfaction. The results show that simply matching students based on goal regardless of other factors may not be a beneficial approach. Overall, students in the Goal-Matched condition achieved lower on a posttest and did not see any difference in satisfaction with their partner compared to students in the *Randomly Matched* condition. However, when we look specifically at students who held the goal of mastering the material during that activity, the results tell a different story. These students did not show lower posttest scores in the Goal-Matched condition, and they reported significantly higher satisfaction with their partner when they were matched based on goal than when they were matched randomly. Since we know that satisfaction in each learning episode can accumulate to have a broader impact, this consideration is a substantial one. Future work should consider this question even more deeply. As we advance our understanding of factors that foster successful collaboration, we can develop adaptive techniques that empower students to reach their learning goals more effectively.

References

Barron, B. (2003). When Smart Groups Fail. *Journal of the Learning Sciences*, *12*(3), 307–359.

Engle, R. A., Langer-Osuna, J. M., & McKinney de Royston, M. (2014). Toward a model of influence in persuasive discussions: Negotiating quality, authority, privilege, and access within a student-led argument. Journal of the Learning Sciences, 23(2), 245-268.

Lewis, C. M., & Shah, N. (2015). How Equity and Inequity Can Emerge in Pair Programming. In *Proceedings of the eleventh annual International Conference on International Computing Education Research - ICER '15* (pp. 41–50). New York, New York, USA: ACM Press.

Lin, L. (2015). Exploring Collaborative Learning: Theoretical and Conceptual Perspectives. In *Investigating Chinese HE EFL Classrooms* (pp. 11–28). Berlin, Heidelberg: Springer Berlin Heidelberg.

Weinberger, A., Stegmann, K., & Fischer, F. (2010). Learning to argue online: Scripted groups surpass individuals (unscripted groups do not). *Computers in Human Behavior*, *26*(4), 506–515.

Acknowledgements

The authors wish to thank the members of the LearnDialogue group at the University of Florida for their helpful input. This work is supported in part by Google through a CS Capacity Research Award and by the National Science Foundation through grant CNS-1622438.