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## Using pair programming as a collaborative learning approach to support students with learning disabilities via Zoom breakout rooms

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**Abstract:** Peer learning through pair programming is a type of collaborative learning that involves students working in pairs to discuss computer programming concepts or develop codes to solve problems. The Zoom breakout room method is applied to teach pair programming in a virtual classroom during the COVID-19 environment. By facilitating pair programming in a virtual learning environment, we gained valuable experience in promoting collaborative learning, active learning, and problem-based learning activities in a cloud setting.

### Introduction

Although computing disciplines can provide prospective job opportunities, many students often find computing courses so frustrating that they either give up or perform poorly. Students with learning disabilities (LD) who enroll in computing courses are especially at risk of falling behind and dropping out of introductory programming courses because of factors associated with their disabilities. Pair programming is a collaborative learning approach as well as a software development technique. When the pair programming method is applied in teaching, two students are paired to work together, side by side, in front of a computer to complete the assignment. They collaborate on the design, coding, and testing on a continuous basis.

Our pair programming project started in a computer lab that hosted 30 to 40 students in the spring semester of 2020. The breakout of COVID-19 in spring 2020 changed the way we teach computing classes. Our university suspended all face-to-face courses and moved them immediately online. The pair programming project team decided to apply the zoom breakout room method to continue the pair programming project. In this presentation, we share our experience teaching computer programming to college students with and without learning disabilities. Our research project has motivated students with LD, who were not computer majors, to learn computer programming.

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In this presentation, we cover (1) collaborative learning for students with learning disabilities; and (2) strategy for teaching pair programming via zoom breakout rooms in the COVID-19 environment.

## **Literature and Background**

Growing enrollments of students with learning disabilities (LD) in postsecondary education and the lower rate (31%) of college completion (Cortiella & Horowitz, 2014), in addition to key legislation such as the American with Disabilities Amendments Act of 2008, have created the need for research on accessibility and success for students with LD in higher education. The relationship between education and employment opportunities is evident from data provided by the Bureau of Labor Statistics (2016).

Collaborative learning can be applied to a pair of students and can also be implemented in larger groups. Peer learning through pair programming is a type of collaborative learning that involves students working in pairs to discuss computer programming concepts or develop codes to solve problems. Two heads are better than one. Two students work together through peer instruction to create computer codes, address misunderstandings and clarify misconceptions. These practices result in higher-level thinking, self-management, and leadership skills.

Research indicates that contextual variables (e.g., quality instruction, opportunities to respond and practice skills) can have a more considerable influence on student performance than “unalterable” outside factors (e.g., ethnicity, disability) and can mitigate any negative situations impacting a student (Greenwood, 2001; Watson, Gable, & Greenwood, 2011). Effective instructional strategies and appropriate accommodations can make learning easier, boost self-esteem, and provide students with LD with a sense of accomplishment and success. The need to support students with LD who struggle in computing courses, improve their educational outcomes, and increase their retention in computing majors compelled us to search for ways to address those students’ needs better.

Pair programming is a collaborative learning strategy. Two programmers work side-by-side at one computer, collaborating on the same design, algorithm, code, test, and helping each other solve problems (Williams, 2010). Typically, a programmer acts as the driver who controls the keyboard and mouse, and writes the code. Another programmer acts as the observer or navigator, and is responsible for reviewing the code, and, at the same time, preventing and identifying logical and syntactical errors in the code (Cockburn & Williams, 2000; Estácio & Prikładnicki, 2015). Each programmer takes a turn being the “driver” and the “navigator.” Several studies (e.g., Lewis 2011; McDowell, Werner, Bullock, & Fernald, 2006; Watkins & Watkins, 2009) have found that pair programming provided substantial benefits for students, such as increased student performance and retention in computer science majors.

## **Teaching Pair Programming via Zoom Breakout Rooms**

Although we have consistently instructed 20+ pair programming sections live in a computer lab, we had not previously transferred the practice to the online format. Before the

semester, we began with a planning meeting to discuss the changes we needed to move the pair programming project online. We chose Zoom breakout rooms for the pair programming exercises in addition to Blackboard, Camtasia, the MOVE platform (a cloud-based lab software environment that our university provides), Visual Basic, and other technologies. The process started with planning and then moved to teach resource management, implementation, reflection, and lessons learned.

#### Step 1 Planning

- Preparation meeting.
- Identify procedures needed for online pair programming sessions.
- Identify technology needed for delivering online programming teaching

#### Step 2 Resource management

- Design course blackboard.
- Record pair programming introductory video.
- Create a video for accessing the university's MOVE platform.
- Schedule online teaching software training for graduate assistants.

#### Step 3 Implementation via Zoom during Pair Programming Session

- Lecture programming
- Assign pairs
- Classroom instruction, such as raise hand if help is needed

#### Step 4 Reflections and Lessons Learned

- Planning a course
- Teaching resource management
- Faculty responsiveness
- Effective and reliable technology
- Online educator's training
- Accommodating students with learning disabilities

Figure 1 provides a detailed the process to teaching pair programming via Zoom breakout rooms.

Figure 1 Process of Teaching Pair Programming via Zoom Breakout Rooms

### **Suggestions for Successfully Using Zoom Breakout Rooms to Teach Pair Programming**

- **Breakout room management.** You can control whether students may return to the main session. If they return to the main session, they can click on "Breakout Rooms" to go back to their assigned room.

- **Host.** Only the Zoom host can assign students to rooms. A Zoom co-host cannot manage breakout rooms. If you want the co-host to manage the breakout rooms, promote him/her to be "host," and he/she will get the Breakout Rooms button. You will be downgraded to co-host.
- **Broadcast Feature.** There is a broadcast feature that will send a brief message to all users in all rooms.
- **Recording.** If the meeting is being recorded to Zoom's cloud, Zoom only records the main room, regardless of what room the meeting host is in. If the local recording is used, it will record the room the participant who is recording is in. Multiple participants can record locally.
- **Assigning groups.** Pre-assigning students to breakout rooms before class starts. Manually assigning a small number of students to breakout rooms during an active Zoom meeting is convenient.
- **Zoom CSV file import.** It saves time to upload a CSV file if you have a large class. You can pre-assign students to specific breakout rooms by importing a CSV file via the Zoom website. The maximum number of students you can have in your CSV file is 200.

## **Discussion**

Undergraduate students with or without disabilities have benefitted from collaborative learning through pair programming. Students and faculty gained a better understanding of the importance of pair programming, respect for all people, and acceptance of diversity and disability. What we have learned from facilitating pair programming via Zoom breakout rooms is to think about pedagogy, collaborative learning, and engagement (Li et al. 2021).

There are several suggestions that we would like to offer to achieve teaching excellence in a virtual environment. First, online teaching requires detailed planning in advance. One of the challenges of conducting pair programming activities online is that both the professor and students are no longer in the same computer lab. Therefore, planning is the key. It is critical to creating clear instructions to ensure student interaction and engagement in a virtual Zoom breakout room. Second, managing teaching resources is an essential component of online education because students will lack traditional hands-on instruction that is available in a physical computer lab. Recording the entire live lecture and posting it on the course blackboard are valuable learning aids to students. Third, timely response to students' requests and answer questions are very important. Students usually ask questions when they are completing course assignments. If timely help can be provided, it will better facilitate student learning. And fourth, the needs of students with learning disabilities should be accommodated in a virtual learning environment. Detailed tutorial material on using online tools can be prepared and offered to students, especially those with LD. The accommodation level for students with disabilities in a pair programming session in a Zoom room should be adjusted accordingly during the class. For example, students with a learning disability need more time to complete computing assignments. We paired graduate students to partner with the undergraduate students with LD to provide longer learning time and additional coding and programming explanations.

## Conclusion

Students were surveyed after the two pair programming modules in our project. Many of the students who participated in the pair programming session reported a positive learning experience and appreciated support from the faculty and hands-on instruction from the professor and graduate teaching assistants. The pair programming approach has made it possible for students to brainstorm to generate solutions to problems.

Educators who have face-to-face classroom teaching experience can adapt our method to deliver their virtual teaching via zoom breakout rooms. To give a successful online pair programming course, we started from course planning, teaching resource management, course implementation, and after-class review lessons. In a face-to-face classroom, the teacher and students can interact with each other to get clarifications about assignments. In a virtual classroom, a clear and precise tutorial at the beginning can help educators engage students in the task that they need to complete. Educators can record a short video to instruct students on how to connect to the virtual lab, how to apply coding techniques, and so on. By facilitating pair programming via the Zoom breakout room technology, we gained valuable experience in promoting collaborative learning, active learning, and problem-based learning activities in a cloud environment. Our results have enriched our knowledge about delivering online education and contribute to the pair programming literature in general.

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