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Abstract:

The coronavirus disease of 2019 (COVID-19) pandemic has required many educators to redesign how they deliver their courses. In this study, we develop innovative procedures and pedagogy to teach pair programming via Zoom breakout rooms in a cloud environment. We report six fundamental innovative teaching mechanisms and procedures: 1) strategically planning a course, 2) effectively managing teaching resources, 3) enhancing faculty responsiveness, 4) selecting reliable technology, 5) mandating online educator's training, and 6) accommodating students with learning disabilities. From teaching pair programming via Zoom breakout rooms, we have gained valuable experience in promoting collaborative, engaging, active, and problem-based learning activities in a cloud environment. Our results enrich our knowledge of delivering online education and contribute to pair programming literature in general.

Keywords: Online Teaching, Pedagogy, Collaborative Learning, Zoom Breakout Room, Pair Programming, Learning Disability.

This manuscript underwent peer review. It was received 7/16/2020 and was with the authors for two months for two revisions. Craig Van Slyke served as Associate Editor.

1 Introduction

The coronavirus disease of 2019 (COVID-19) pandemic abruptly transformed teaching and learning. In the new world of social distancing, higher education has made a quick transition to virtual teaching and learning. The paradigm shift in the learning mechanism has broadened our teaching skillset and knowledge about disseminating instruction methods.

Many beginners, especially those who do not major in computer sciences, find learning computer programming challenging. Pair programming has proven to be a feasible method to improve programming performance in and outside the academic environment (Yuan & Cao 2019). However, to our knowledge, published research or conference papers have not previously discussed teaching pair programming to students with disabilities via Zoom online technology. Pair programming refers to a software-development technique in which two programmers, one who serves as driver and one who serves as navigator, work together at one workstation. The driver writes code while the navigator observes and reviews the code as the driver writes it (Williams, McCrickard, Layman, & Hussein, 2008; Yuan & Cao, 2019).

We conducted a study to develop innovative procedures and pedagogy to teach pair programming to students with disabilities via Zoom breakout rooms in a cloud environment. Specifically, we systematically planned digital courses, implemented pair programming via Zoom breakout rooms, developed innovative pedagogy to mentor students with learning disabilities to learn programming, and facilitated knowledge dissemination in the higher education community. We discuss lessons we learned from this innovative teaching pedagogy and strategies to enhance students' online learning experience and learning outcomes for college students with learning disabilities.

We do not discuss our pair programming project's outcomes in this paper. Rather, we focus on the process of designing and delivering pair programming in an online learning environment. We discuss the programming project's outcomes in a separate paper (Pribesh et al., 2019).

2 Background

2.1 The Issue: Facilitating Pair Programming

We conducted a study to develop innovative procedures and pedagogy to teach pair programming via Zoom breakout rooms in a social distancing learning environment as part of a larger research project on the effectiveness of pair programming for students with learning disabilities (LD) that the U.S. National Science Foundation (NSF) funded. The project originally focused on assessing whether pair programming constitutes a useful intervention or pedagogical strategy to support college students in programming classes who do not major in computer sciences and who have a learning disability. The COVID-19 pandemic altered our initial data-collection plan in a computer lab. As a result, we implemented an innovative approach to facilitate pair programming online to support students with LD.

2.2 Challenge: Transition from Physical Classroom to Online Education

On 11 March, 2020, during the break in the semester at the time, our university president announced the decision to suspend in-person classes and move them immediately online. Meanwhile, the pair programming project team had completed all in-class pair programming assignments for the semester except for the post-survey that the team eventually completed online.

The challenge we faced concerned how we would fulfill the goal of pair programming for students with LD in an unprecedented social-distancing environment. We designed the original research project in a computer lab with hands-on assistance from faculty and graduate students. However, the COVID-19 pandemic drastically disrupted teaching and learning. In order to continue our research project, we decided to facilitate pair programming in a cloud learning setting.

Before the university closed in the pandemic season, it offered various online courses, but we had never conducted pair programming online. Due to the pandemic, we had to apply digital devices, use online resources, and facilitate e-learning activities. We focused on continuing to assist students with LD to learn programming and make academic progress. We decided to apply Zoom breakout room technology to facilitate pair programming in the semester that ran from June to August as an opportunity to accumulate pedagogical experience from which draw insight to enhance our ability to teach online.

3 Teaching Pair Programming Online

3.1 Content

In the June-August semester in 2020, 75 undergraduate students enrolled in three information technology (IT) courses. Students had voluntarily reported their learning disability status, which our university's Office of Educational Accessibility assessed based on criteria under Section 504 of the Rehabilitation Act of 1973 (U.S Department of Education, 1974).

We incorporated Visual Basic, Net programming, and programming exercises and activities into the course materials to help implement pair programming (see Table 1). We designed two training modules that each included three sections:

1) A discussion on a real-life topic with a design problem that depended on software-development techniques.
2) An introduction of the corresponding software-development skills, tools, and platforms.
3) A guided hands-on lab session in which participants worked in pairs to apply the software-development techniques to solve problems and implement their ideas.

We provide more details in the Appendix. For example, Module 1 covered five items:

1) Advice on how to access the university's MOVE virtual lab. We pre-recorded instructions in a step-by-step video presentation. Additionally, we advised students to download the Zoom software that the university supported.
2) A pre-recorded lecture called "what is pair programming?".
3) Hands-on instruction on the pair-programming assignment that we delivered via Zoom.
4) An assignment that students worked in pairs on in Zoom breakout rooms. They introduced themselves and decided who would drive and who would navigate. If students had questions, they could type "Yes" in a relevant block in the table posted in a Google Doc, and a TA would enter the breakout room to help
5) A survey that students completed after completing the pair-programming assignment to review their experience and perspective (see Appendix).

In addition to the three sections that each module covered, we integrated two topics into the two modules: 1) object-oriented programming (OOP) and graphical user interfaces design (GUI), and 2) data stored and manipulated in the program (see Table 1).

Table 1. Module Topics

Sections	Module 1	Module 2
1) Real-life topic	OOP and GUI	Data storage and manipulation
2) Software-development technology	VB.net, Visual Studio	VB.net, Visual Studio
3) Hands-on activity	A self-introduction program	A calculator program

3.2 Online Teaching Procedure

3.2.1 Planning and the Process of Implementing Programming via Zoom Breakout Room

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. We began with a planning meeting in May before the semester started to discuss the changes that we needed to implement 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. We chose Zoom platform because our university provides technical support for this technology. In Figure 1, we detail the process we followed to facilitate pair programming online. The process began with planning and then moved to teaching resource management, implementation, and reflection and lessons learned.

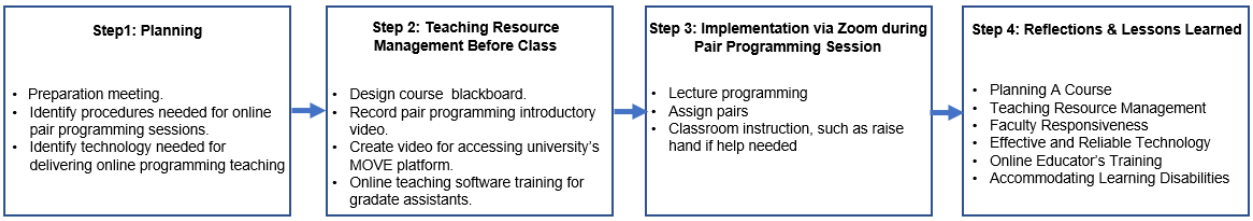

Figure 1. Process for Pair Programming via Zoom Breakout Room

3.2.2 Zoom Breakout Room Management

At the planning meeting, we created instructions and rules for conducting pair programming and effectively managing Zoom breakout rooms. The results included:

- Testing video-sharing's capability and stability between dozens of breakout rooms before class started.
- Assigning two students to a breakout room to collaboratively complete the programming assignments.
- Noting that the instructor or teaching assistants (TAs) could only join one of the breakout rooms at a time to answer questions and to provide instruction.
- Recognizing that students would need to raise their hands in the chat box to signal their need for help.

Furthermore, we specified guidelines for interaction management during a Zoom breakout session:

- **Instructor and students**: instructors would use the Zoom master room to deliver lectures by sharing their screen.
- **Student and student**: we would assign students in pairs to Zoom breakout rooms to work together; they could freely talk and illustrate their work with each other.
- **Teaching assistants and students**: whenever students had questions in their own breakout meeting room, they would post an "ask for help" message in a shared Google Doc. TAs would watch and make direct contact with them by joining in their breakout rooms.

When the Zoom classes began, instructors gave all students a course orientation and trained them to play the driver and navigator roles that pair programming requires.

4 Discussion

From facilitating pair programming via Zoom breakout rooms, we learned not to get bogged down with the technology but to think about pedagogy, collaborative learning, and engagement—central learning tenets regardless of whether students learn face-to-face or online (Tan et al., 2017). Below, we offer six suggestions that we consider important for teaching excellence in a virtual environment.

1) **Planning the course**: online courses require detailed planning in advance. Online pair programming activities create challenges associated with the fact that professors and students do not reside in the same computer lab. Instead, self-motivated engagement drives much learning. As a result, educators need to plan appropriately. To ensure student interaction and engagement in a Zoom breakout room, one needs to design pair programming activities with clear instructions.

2) **Teaching resource management:** one needs to manage teaching resources in online education. Recording the entire live lecture and offering it to students online ensures that students have the resources that they need to succeed in the course.

3) **Faculty responsiveness:** even though online courses occur online, instructors need to respond to student requests in a timely manner. Students usually ask questions when they are completing course assignments. Timely answers better facilitate student learning.

4) **Effective and reliable technology:** technology constitutes the way we can reach our students in online learning. Accordingly, in order to articulate the skills and competencies that online teaching requires to succeed, one needs to use effective and reliable technologies. We used

Blackboard, Zoom breakout rooms, Zoom for team meetings, the MOVE platform (i.e., a cloud-based lab software environment that our university provides), and others to develop and implement a successful online course. We also strongly recommended that students use computers rather than smart phones while doing online pair programming exercises in order to minimize technology difficulties.

5) **Online educator's training**: faculty need to develop their skills to ensure distance-education programs succeed. We required both instructors and graduate teaching assistants in this project to be familiar with online teaching tools and to practice with telecommunication tools.

6) **Accommodating learning disabilities**: educators should offer detailed tutorial material on using online tools to students, especially students with LD. They also need to accommodate students with disabilities in a pair programming session in a Zoom room accordingly during the class. For example, one can assign a graduate teaching assistant as the pair for a student with a learning disability to provide detailed instruction and to offer a longer learning time (since some LD students need more time to complete a task).

4.1 Student Feedback: Positive Response

We surveyed students after they completed the two pair programming modules. In Table 2, we provide some sample comments. Many students who participated in the pair programming session reported positive learning experience and appreciated the support and hands-on instruction from the professor and the TAs. The pair programming approach made it possible for them to brainstorm to generate solutions to problems.

Table 2. Positive Feedback from Students

	Positive feedback from students
Student learning experience	*What I enjoyed was the correlation to the lecture and the hands-on programming assignment.* *I appreciate how the project wasn't too complicated, but just enough to keep me engaged and allowed me to learn how to compute it.* *What I enjoyed most through this assignment was that I learned the meaning behind class, properties, objects, methods, and events regarding coding in the visual studios' program.* *It's much different than coding I've done in the past. The click and drag simplicity of text boxes, labels, etc. is nice and makes the coding not so tedious.*
Responsiveness of instructors and coaching in zoom breakout rooms	*The professor is very nice for teaching me step by step. I feel like this programming exercise allows for lots of creativity and will be useful to me later.* *I enjoyed how well the lab instructor explained the steps making it simple for people like me who rarely code.* *I am happy with how helpful our TA was. I had no clue how to do computer programming at first, but now I understand more which is why I think this experience was good for beginners like myself.*
Pair programming for students with learning disabilities	*The ability to interact with others on an enjoyable project.* *I liked working with a partner. It made the whole experience much more fun.* *I enjoyed everything especially the pair programming, where driver and navigator work together.* *Learning from my peers. Putting our brains together to get a result.*

4.2 Student Feedback: Areas Needed to Be Improved

Although the majority of the students offered positive feedback about learning pair programming via the Zoom breakout room technology, some students pointed out areas that we needed to improve in. In Table 3, we list issues that they mentioned. Readers who have an interest replicating our online Zoom breakout room teaching method may consider developing improvements in these areas when they design their own online courses.

First, educators need to develop a detailed teaching and learning resource. We recorded videos in advance to show how to connect to the MOVE cloud computing platform that our university supports. Some students could not locate the instructions for certain tasks in the video. We plan to create a list of

tasks recorded in the video with a time-mark so that students will be able to locate the information quickly. We did not record breakout room activity. We advise our colleagues to record breakout room activity for after-class review.

Second, educators require efficient and reliable technology to successfully deliver online courses. Some students reported that it took too much time to load the program from a remote virtual computing lab and that their own Internet carrier sometimes lacked reliability. We suggest that universities set up computer labs on campus for students who do not have current communication technology at home.

Finally, educators can adopt a flexible method to pair students. We used a random pairing method. Some students like to work with a peer whom they know. Future research can explore the effects of different pairing methods for collaborative learning.

Table 3. Feedback from Students: Areas that Needed Improvement

	Feedback from students
Teaching and learning resource 1) Before class: Introductory video 2) After class: video recorded in the breakout room	*I had never done any type of coding so I was confused at the beginning.* *The first meeting was hard to follow. The second meeting was easier because I knew what to expect.* *A step by step tutorial would have assisted a lot. It was there but I could not find it.* *I would like to re-watch the video to understand where we went wrong.*
Technology 1) Technology on the student side 2) Technology on the university side	*It's hard for people who is not familiar with computers.* *Having to use Move.odu. It was extremely difficult for me. It takes a long time to load.* *Cox Communication is trash and my service keeps going out.*
Student pairing method	*My partner was not able to point things out on my screen or directly collaborate which made the process slower and more tedious.* *Partners are assigned randomly; instead of assigning the groups randomly I think that it would facilitate the process to keep the same pair on both parts of the assignment.*

4.3 Suggestions for Professors Who Are Interested in Adapting Our Method

Educators who have face-to-face classroom teaching experience can adapt our method to deliver their teaching online. To deliver a successful online pair programming course, we needed to design a detailed process for collaborative learning starting from course planning, teaching resource management, course implementation, and after-class review lessons. In Section 4, we offer six suggestions that we consider important for teaching excellence in a cloud learning environment. Students need a warm-up period to get into the topic. 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 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 Visual Basic, and so on. In Section 5, we discuss the lessons that we learned that other educators use as a springboard to teach well in the cloud learning environment.

5 Lessons Learned and Future Directions

By facilitating pair programming via Zoom breakout rooms, we accumulated valuable experience in enhancing collaborative learning in an online class. Gleaned from feedback from the students, we provide some sample comments regarding directions for improvement. Many students who participated in the pair programming sessions reported a positive learning experience and appreciated the support and hands-on instruction from the professor and the TAs. The pair programming approach made it possible for them to brainstorm together in order to generate solutions to problems.

Now, we have an excellent opportunity to pause and to reflect on the experience. We present five lessons that we learned:"

1) **Interaction level**: the professor, the TAs, and students interact less in the online setting when we compare facilitating pair programming online with that in a computer lab. One possible reason could be that student pairs in a Zoom breakout room cannot interact with pairs in other Zoom rooms. We suggest that instructors ask students to post their questions on a discussion

platform so that they can share their views and programming experiences among all of the students to improve the interaction level in the course. We recommend that instructors provide additional communication methods outside the Zoom environment, such as shared Google documents and a virtual white board, to help students more effectively share ideas with their classmates.

2) **Participation check**: unlike in a computer lab where instructors can walk around the room and check each student's attendance and participation, they cannot observe all groups at the same time in Zoom breakout room setting. We suggest that instructors add quiz games to motivate students' engagement.

3) **Course design and lecture delivery**: teaching IT-specific skills online such as coding, testing, debugging, and system integration have proven to be a challenging issue. We suggest using a hybrid approach by meeting students online in a Zoom classroom and developing videos and other learning resources to provide visual hands-on instruction.

4) **Time schedule**: to give students more flexibility, we suggest that instructors integrate both synchronous and asynchronous tactics to deliver their pair programming assignments. Instructors should encourage students to meet outside the scheduled class time to complete pair programming assignments as needed.

5) **Pairing method**: instructors can follow a more flexible method to create pairs. Rather than self-pairing and random-pairing methods, we also intentionally assigned students to pairs based on their background. Instructors can apply different pairing methods to improve diversity and to increase creativity.

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 enrich our knowledge about delivering online education and contribute to the pair programming literature in general. We hope that our experience can guide future research and provide possible interventions for instructors who approach learning differently.

Researchers follow and extend our study in several ways. They could test various popular online platforms, other than Zoom, that support teaching online programming classes. They could also explore specific pairing methods' effectiveness, such as random pairing, pairing based on majors, and paring based on acquaintance experience.

Acknowledgments

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References

Pribesh, S., He, W., Watson, S., Major, D., Xu, L., Li, L., Tian, X., Gorkhali, A., & He, Y. (2019). Students with learning disabilities, pair programming and situational motivation. In *Proceedings of Society for Information Technology & Teacher Education International Conference*.

Tan, W., Chen, S., Leer, L., Ling, X. L., Tang, A., & Wang, T. (2017). A method toward dynamic e-learning services modeling and the cooperative learning mechanism. *Information Technology and Management*, *18*, 119-130.

U.S. Department of Education. (1974). *Section 504 of the Rehabilitation Act of 1973.* Retrieved from https://www2.ed.gov/policy/rights/reg/ocr/edlite-34cfr104.html

Yuan, H., & Cao, Y. (2017). Hybrid pair programming—a promising alternative to standard pair programming. In *Proceedings of the 50th ACM Technical Symposium on Computer Science Education.*

Williams, L., McCrickard, D. S., Layman, L., & Hussein, K. (2008). Eleven guidelines for implementing pair programming in the classroom. In *Proceedings of the AGILE Conference.*

Appendix

Pair Programming Module 1: Introduction to VB.net

Outline of Module 1

1) Getting started: things to do before the hands-on lab.
2) Self-learn "what is pair programming": pre-recorded video posted on the course Blackboard.
3) Lecture: learn how to use Visual Studio and the basic concepts of VB.net programming language.
4) Hands-on lab: an assignment to work in pairs.
5) Mid-survey: review your experience and perspective.

Item 1: Getting Started: Things to do Before the Pair Programming Hands-on Lab

1) Make sure you can access ODU MOVE and log in College of Business computer. Instruction is here. If you are not able to access the virtual computer lab, please let us know in the Zoom chat immediately and send an email to itshelp@odu.edu.
2) Download the lecture slides.
3) Follow the live lecture and take notes. You may follow the instructor's action to practice programming.
4) If you have questions, feel free to ask in the chat room when you are in the master room.

Item 2: Self-learn the Lecture on "What is Pair Programming"

Item 3: Lecture: Learn How to Use Visual Studio and the Basic Concepts of VB.net Programming Language

Step 4: Hands-on Lab

Assignment: for your first Visual Basic exercise, you must first complete the hello world project and then add buttons and event procedures to display your group name (assign a fancy name for your group) and your interest (sports / movie). You are encouraged to modify the user interface to suit your preference. For example, see Figure A1.

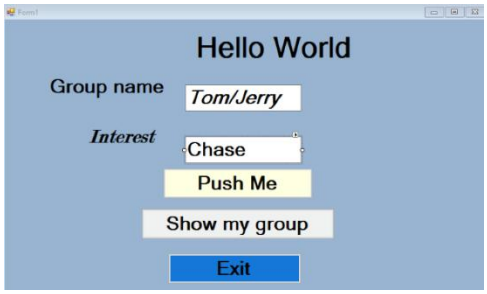

Figure A1. Hello World Project

Assignment policy:

1) Two students work together in one breakout room using virtual computer lab. You will be paired with a partner randomly to a breakout room. Do a self-introduction with your partner and decide who will play the role of driver first to do programming and share screen, and who will be the navigator.
2) Once you are in the Breakout Room, write down your name in the shared doc in the corresponding block in the Breakout Room Table shown below.
3) If you need help to complete the assignment, you should type "Yes" in the relevant block in the following table, a TA will go to your breakout room to help you. After the TA has resolved your issue, he/she will clear the block to null.

4) After you have completed the assignment, let us know by typing “done”. The TA will go to your breakout room and check the result. If everything looks great, the TA will put “yes” in the check block.

Table A1. Breakout Room Table (Module 1)

Breakout room no.	Driver’s name	Navigator’s name	Help?	TA’s name	Check whether finished (TA only)
1 (example)	Tom	Alice	Yes/null	YH	Yes
2					
3					
4					
5					

Item 5: Mid-survey: Review your Experience and Perspective

After finishing the assignment, both of you are required to complete the mid-survey on the blackboard.

Pair Programming Module 2: Introduction to VB.net

Outline of Module 2

1) Things to do before the hands-on lab
2) Lecture 2: Review Lecture 1 and learn more syntax of VB.net
3) Hands-on lab: An assignment that you and your partner will complete together as a pair.
4) Post-Survey: Review your experience and perspective.

Item 1: Things to do Before the Hands-on Lab

1) Mid-survey is posted on the course blackboard. If you have not done it, please finish it now.
2) Make sure you can access ODU MOVE and log into College of Business virtual computer lab. Instruction is here. If you are not able to access the virtual computer lab, please let us know in the Zoom chat immediately.
3) Download the lecture slides.
4) Follow the live lecture and take notes. You may follow the instructor's action to practice programming.
5) If you have questions, feel free to ask in the chat room when you are in the master room.

Item 2: Lecture

Review the first lecture and deliver the second lecture on more syntax of VB.net.

Item 3: Hands-on Lab

Assignment: for the Visual Basic exercise, you must first complete the calculator project, and then add buttons and event procedures to include a "subtraction" function. Additionally, you will calculate the average score by arbitrary two scores. For example, see Figure A2.

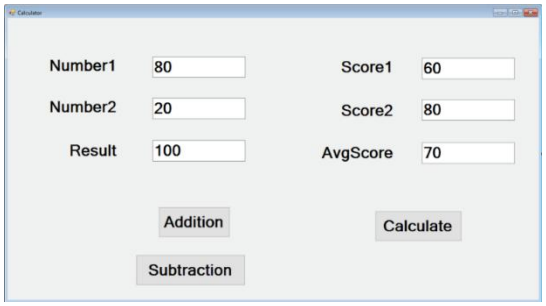

Figure A2. Calculating Average Scores

Assignment policy:

1) Two students are supposed to work together in one breakout room. You will be assigned with a partner randomly to a Breakout Room and you need to select who works as a driver to do programming and share screen. The other works as a navigator to help.
2) Once you are in the Breakout Room, write down your name and ID in the shared doc in the corresponding block in the breakout room table as shown below.
3) If you need help to complete the assignment, you should type "Yes" in the relevant block in the table below. Then, a TA will go inside your breakout room to help you. After the TA resolves your problem, he/she will clear the block to null.
4) After you have completed the assignment, let us know by typing "done" in the table. The TA will enter your breakout room and check the result. If everything looks great, he/she will put "Yes" in the check block.
5) After you have completed the assignment, both of you are required to finish the post-survey that is posted on the course blackboard.

Table A2. Breakout Room Table (Module 2)

Breakout room no.	Driver's name and ID	Navigator's name and ID	Help/done?	TA's name	Check whether finished (TA only)
1 (example)	Tom / 01	Alice / 02	Done	YH	Yes
2	Austin / 03	Zodboy / 04	Done	YH	Yes
3	Tieku / 05	Byron / 06	Done	MB	Yes
4	Optiz / 07	Fanyu / 08	Done	MB	Yes
5	Phil / 09	Tanner /10	Done	LX	Yes

Item 4: Post-survey: Review your Experience and Perspective

After finishing the assignment, both of you are required to complete the post-survey on the course blackboard.

About the Authors

Ling Li is the Chair of the Department of Information Technology and Decision Sciences at Old Dominion University, USA. She is eminent scholar and university professor. She has published over 140 peer-refereed research papers in high-quality journals. Her research is motivated by theoretical and practical explanations of how organizations can best deploy their technology and supply chain strategies for competitive advantage. She serves as area editor, associate editor and editorial board member of several journals.

Li Da Xu is eminent scholar and professor of Information Technology at Old Dominion University. He is an IEEE Fellow, academician of the European Academy of Sciences, and academician of the Russian Academy of Engineering (formerly USSR Academy of Engineering). He is a Highly Cited Researcher in the field of engineering named by Clarivate Analytics (formerly Thomson Reuters Intellectual Property & Science) for five consecutive years from 2016 to 2000.

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Shana Pribesh is a professor of educational research in the Educational Foundations & Leadership Department in the Darden College of Education and Professional Studies at Old Dominion University. She is interested in structural inequality in education systems. She examines systems of inequality for students at-risk; namely those who live in poverty, make residential moves, have disabilities, attend schools with fewer resources, take developmental education courses and live in less traditional family structures. Recently she has been engaged in research that spans multiple countries to determine if patterns stemming from systems of inequality are similar in varying contexts.

Silvana M. R. Watson is a professor of special education at Old Dominion University. Her research interests focus on 1) promoting evidence-based practices for students with learning disabilities, attention deficit hyperactivity disorders, and English learners with and without disabilities; 2) teacher preparation; and 3) examining the nature of students' learning difficulties. Her has disseminated her work through presentations at international, national, and state professional conferences, peer-reviewed publications, book chapters, other academic publications, and consultations with educational agencies. She is one of the co-PIs of the National Science Foundation's grant awarded to Old Dominion to support the investigation of pair programming as a teaching method to support undergraduate students with learning disabilities taking instructional technology courses. She has been awarded a large grant from the U.S. Department of Education, Office of English Language Acquisition, to assess and instruct English learners with and without disabilities.

Debra A. Major is a professor and eminent scholar in the College of Sciences at Old Dominion University, USA. Her professional specialty is industrial/organizational psychology. Her research focuses on barriers encountered by women and ethnic minorities pursuing educational and career pathways in STEM. She is especially interested in improving persistence and recently developed and validated instruments for assessing students' embeddedness in STEM majors and the broader university.