

Jeffrey Bishop Bush

University of Colorado at Boulder • jeffrey.bush@colorado.edu

CURRENT POSITION

2020-present Research Scientist Level 2, Institute of Cognitive Sciences, University of Colorado at Boulder

AREA OF SPECIALIZATION

I research the intersection of technology, STEM teacher learning and professional development with sub-topics of mathematics education, computational thinking, physical computing, formative assessment, complex instruction, Artificial Intelligence, user experience research, compassion, and equity.

Work at the University of Colorado's Institute for Student and AI Teaming (iSAT) focuses on creating an AI agent and associated curriculum to support collaborative learning, promote equity and uplift non-dominant student ideas. My work there focuses on curriculum development, teacher professional learning communities for co-design, and UX design.

Recently funded work focuses on creating an AI-augmented support model for algebra tutors to improve relational dynamics, equitable teaching practices and cognitive demand matching.

Before joining ICS in 2020, my research focused primarily on technology to catalyze high leverage teacher practice relating to formative assessment and equitable discourse in middle and high school mathematics classrooms.

EDUCATION

University of Colorado at Boulder

Ph.D. in Education - Curriculum and Instruction - David C. Webb, Advisor

University of Colorado at Boulder

M.A. in Education - Curriculum and Instruction

Bowdoin College

B.A. in Environmental Studies and Geology, Mathematics Minor

RELEVANT PROFESSIONAL EXPERIENCE

Four years teaching high school mathematics and geology

The White Mountain School and Swiss Semester

Four years as a Consulting Researcher and Content Specialist

Woot Math (now Saga Education), Boulder, CO

Visiting Faculty teaching Math for Elementary School Educators for two years

Colorado College, Colorado Springs, CO

Seven summers as a professional wilderness expedition guide for teens through the YMCA

Ely, MN

CONFERENCE AND JOURNAL PUBLICATIONS

Dixon, J., Hennessy Elliott, C., Bush, J.B., Recker, M., (2023). Examining Teachers' Beliefs About 3-D Learning: The Importance of Analyzing Multiple Data Sources. Paper to be presented at the 2023 AERA Conference, Chicago, IL. April 14, 2023.

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Dixon, J., Hennessy Elliott, C., Gendreau Chakarov, A., Schneider, M., Bush, J.B., Recker, M., (2023). Toward a Middle School Debugging Pedagogy With Physical Computing Systems. Paper to be presented at the 2023 AERA Conference, Chicago, IL. April 14, 2023.

Hennessy Elliott, C., Gendreau Chakarov, A., Bush, J. B., Nixon, J., & Recker, M. (2023). Toward a debugging pedagogy: helping students learn to get unstuck with physical computing systems. *Information and Learning Sciences*.

Bush, J.B., Dey, I., Chang, M.A., Perkoff, M. (2022) Envisioning a Classroom AI as a Community Builder. Short paper presented at 23rd International Conference, AIED 2022, Durham, UK, July 27–31, 2022

Hennessy Elliott, C., Gendreau Chakarov, A., Bush, J. B., Nixon, J., Recker, M. (2022) “Do I need to know what I am doing if I am the teacher?” Developing teacher’s skills supporting debugging practices with physical computing. Paper presented at the annual meeting of the International Conference of the Learning Sciences, Hiroshima, Japan.

Bush, J.B., Hennessy Elliott, C., Gendreau Chakarov, A., Bidy, Q. (2022) Understanding the Collaborative Learning Implementation Cycle for a Teacher Learning to Promote Computationally Rich Communication in a Remote STEM Classroom. Paper submitted to be presented in the Computer Supported Collaborative Learning strand of the annual meeting of the International Conference of the Learning Sciences, Hiroshima, Japan.

Bidy, Q., Bhaduri, S., Bush, J.B., Hennessy Elliott, C., Recker, M., Sumner, T. (2022) Co-designing Opportunities for Rural Middle School Youth to Engage with STEM Careers and Career Pathways. Round table session for Division C of the 2022 AERA Conference, San Diego, CA April 21, 2022.

Hennessy Elliott, C., Gendreau Chakarov, A., Bush, J. B., Recker, M. (2022) Debugging pedagogies: Helping Middle School Students Learn to get Unstuck with Physical Computing Systems. Paper presented at the 2022 AERA Conference, San Diego, CA. April 21, 2022.

Bush, J.B. (2021) Software-based intervention with digital manipulatives to support student conceptual understandings of fractions. *British Journal of Educational Technology*, 00, 1– 20. <https://doi.org/10.1111/bjet.13139>

Gendreau Chakarov, A., & Bush, J.B., & Bidy, Q. L., & Jacobs, J., & Recker, M., & Sumner, T. (2021). Supporting Teachers to Implement Engineering Design Challenges using Sensor Technologies in a Remote Classroom Environment Paper presented at 2021 ASEE Virtual Annual Conference Content Access, Virtual Conference. <https://peer.asee.org/37789>

Srinjita Bhaduri, Quentin L Bidy, Jeffrey Bush, Abhijit Suresh, and Tamara Sumner. (2021). 3DnST: A Framework Towards Understanding Children’s Interaction with Tinkercad and Enhancing Spatial Thinking Skills. In *Interaction Design and Children (IDC '21)*. Association for Computing Machinery, New York, NY, USA, 257–267. DOI:<https://doi.org/10.1145/3459990.3460717>

Gendreau Chakarov, A., Bush, J.B., Bidy, Q., Jacobs, J., Hennessy Elliott, C., & Sumner, T. (2021). Challenges and Unexpected Affordances of Physical Computing Going Remote. *Interaction Design and Children*. Retrieved from <https://par.nsf.gov/biblio/10291783>.

Bidy, Q. Gendreau Chakarov, A., Bush, J.B., Hennessy Elliot, C. Jacobs, J., Recker, M., Sumner, T., & Penuel, W. (2021). A professional development model to integrate computational thinking into middle school science through co-designed storylines. *Contemporary Issues in Technology and Teacher Education*, 21(1), 53-96. Retrieved from <https://par.nsf.gov/biblio/10291724>.

Bush, J.B., Miller, S., Gilmore, M. (2020). Drag and Drop Programming Experiences and Equity: Analysis of a Large Scale Middle School Student Motivation Survey, paper presented (virtually due to COVID-19) at the *Special Interest Group of Computer Science Education (SIGCSE 2020)*, Portland, Oregon. Retrieved from <https://dl.acm.org/doi/abs/10.1145/3328778.3366875>

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- Bush, J.B., Marks, K. (2019). Technology Mediated Classroom Assessment: Co-Design of Features and Tasks for Student Response Systems and Effective Pedagogy in Algebra. Paper presented the *Third Annual NCME Special Conference on Classroom Assessment*. Boulder, Colorado.
- Bush, J.B., Webb, D. C., Kress, N. E., Yang, W., & Perkins, K. K. (2018). Classroom Activities for Digital Interactive Simulations to Support Realistic Mathematics Education. Paper presented at the *Sixth International Realistic Mathematics Education (RME6) Conference*. Grand Cayman, Cayman Islands. Retrieved from https://www.researchgate.net/publication/330812204_Classroom_Activities_for_Digital_Interactive_Simulations_to_Support_Realistic_Mathematics_Education
- Bush, J. B., Milne, B. Technology to Support Students' Learning Mathematics from Other Students' Work. (2018). Poster presented at the annual meeting of the International Conference of the Learning Sciences, London, UK.
- Bush, J. B., Milne, B. Making Mathematical Thinking Visible Through Technology. (2018). Poster presented at the annual meeting of the International Conference of the Learning Sciences, London, UK.
- Bush, J.B., Marks, K., Milne, B. (2017). Design Considerations for a Web-Based Formative Assessment tool to Support Collaborative Learning in Mathematics. Presentation at *the International Society for Design and Development in Education Conference*. Berkeley, California.
- Bush, J.B., McGarry A., Webb, D.C. (2017). Co-Design of Activities for PhET Simulations, Balancing Reform and Reality. Presentation at the *International Society for Design and Development in Education Conference*. Berkeley, California.
- Webb, D.C., Nickerson, H., Bush, J.B., (2017). A Comparative Analysis of Online and Face-to-Face Professional Development Models for CS Education, paper presented at the *Special Interest Group of Computer Science Education (SIGCSE 2017)*, Seattle, Washington. Retrieved from <https://dl.acm.org/doi/10.1145/3017680.3017784>
- Bush, J.B., and Miller, S. (2017). Analysis of Associations between Motivation and Previous Computer Science Experience, Gender, Ethnicity and Privilege as Observed in a Large Scale Survey of Middle School Students", poster presented at the *Special Interest Group of Computer Science Education (SIGCSE 2017)*, Seattle, Washington.
- Nickerson, H., Bush, J.B., and Endo, Y, C. (2016). We Have Questions: Pedagogical, Technical, and Procedural Assistance Requests in a Large Computational Thinking Curriculum Research Project, poster presented at the *Special Interest Group of Computer Science Education (SIGCSE 2016)*, Memphis, Tennessee.

INVITED PRESENTATIONS

- CS4All Accelerator Program, Remote (2023) SchoolWide Labs: Programmable Sensors, Artificial Intelligence and Storylined Curriculum to Promote Collaborative Learning and Equity in STEM Education
- White House Office of Science and Technology Policy, Active Learning in STEM Education Symposium, Washington D.C. (2016). *Active Learning Methods? Let me count the ways! Integrating Computational Thinking and Number Sense in Mathematics*

CONFERENCE PRESENTATIONS

- Bush, J.B., Dey, I., and Hoang, N., Reflective, Iterative and Interdisciplinary Design of a Situated Coding Scheme for Classroom Collaborative Work. Paper presented to the Collaborative Analytics Workshop at the 13th International Learning Analytics and Knowledge Conference Arlington, TX. March 14, 2023
- Bush, J.B., McGarry A., Perkins, K., and Webb, D. *Teaching and Learning Algebraic Thinking Across Middle Grades: A Research-based Approach Using PhET Interactive Simulations*. The Center for STEM Learning's 11th Annual Symposium. Boulder, CO. 2019

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Bush, J.B. *Supporting Collaboration and Discourse in Mathematics with Interactive, Digital Tools*. Presentation at the Annual Conference of the Colorado Council of Teachers of Mathematics, Denver, CO. 2019

McGarry A., and Bush, J.B. *Implement Effective Math Teacher Practices Using Interactive Simulations* Colorado Council of Teachers of Mathematics Annual Meeting Denver, CO 2017

McGarry A., Perkins, K., and Bush, J.B. *PhET Interactive Simulations: Making STEM More Accessible*. The Center for STEM Learning's 9th Annual Symposium. Boulder, CO 2017

Current Research Support

Human Tutoring Augmented by Artificial Intelligence (AI): Tutoring Analytics and Performance Support (TAPS)

Source of Support: National Science Foundation (NSF# 2222647)

Total Award Amount: \$1,800,000

NSF National AI Institute for Student-AI Teaming (iSAT)

Source of Support: National Science Foundation (NSF# 2019805)

Total Award Amount: \$19,993,294

Developing a model of teacher learning to support computationally rich communication in science classroom

Source of Support: James S. McDonnell Foundation

Total Award Amount: \$2,500,000

Collaborative Research: DTI: STEM Career Connections:

A model for preparing economically-disadvantaged rural youth for the future workforce

Source of Support: National Science Foundation (ITEST NSF 19-583)

Total Award Amount: \$599,660

Collaborative Research: SchoolWide Labs: A real-time sensing platform for integrating computational thinking into middle school STEM curricula

Source of Support: National Science Foundation (NSF #1742053, #1742046)

Total Award Amount: \$2,123,801

Completed Research Support

To conduct research and development of technology-enabled approaches in middle years math that could lead to dramatic impact on student learning.

Source of Support: Bill and Melinda Gates Foundation, awarded to Woot Math in 2018

Total Award Amount: \$460,755

A Novel Platform for High-Quality Formative Assessment in Mathematics

Source of Support: Institute of Educational Sciences, Phase I and Phase II

Total Award Amount: \$150,000 and \$900,000

Teaching and Learning Algebraic Thinking Across the Middle Grades: A Research-based Approach Using PhET Interactive Simulations

Source of Support: National Science Foundation DRK12

Total Award Amount: \$2,199,109

A Question of Numbers: Numeracy, Learning, and Learning about Learning

Source of Support: National Science Foundation SBIR Phase I and Phase II

Total Award Amount: \$150,000 and \$1,275,000

oDREAMS: Promoting Computational Thinking through Game & Simulation Design and iTEST (Innovative Technology Experiences for Students and Teachers) scale up

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Source of Support: National Science Foundation

Total Award Amount: 1,920,020.00

PUBLICATIONS IN PROGRESS

Bush, J.B. Bhaduri, S., Rummel, M., Chang, M., Bidy, Q., (2023) Computing for OUR future: multiple case study analysis of youth's empowerment to use sensor technology to address personally relevant community issues during a career mentor infused STEM program. Invited submission to International Journal of Child-Computer Interaction special issue on Computational Empowerment. Manuscript in review

Bush, J.B. (2023) Student Response Systems to Facilitate Formative Assessment: Linking Representations, Student Ideas and Discourse in Algebra Classrooms. Manuscript in preparation.

Bush, J.B., Webb, D.C., Perkins, K. (2022) Simulations as an Instructional Catalyst: A Study of Change in Middle Grades Mathematics Teacher Practice. Manuscript in preparation for JMTE.

Hennessy Elliott, C., Nixon, J., Gendreau Chakarov, A., Bush, J.B., Schneider, M., & Recker, M. Characterizing teacher support of debugging with physical computing: Towards a debugging pedagogy ACM Transactions on Computing Education (TOCE), manuscript in review

Dickler, R., Hirshfield, L., Reitman, J., Chang, M., Lieber, R., Bush, J., Breideband, T., Weatherly, J., Foltz, P. Theory-driven Display Design to Support Collaboration in Small Groups in a Symposium co-chaired by Tissenbaum, M., and Puntambekar, S., called: Theory-driven development of classroom orchestration tools to support learning at multiple social planes. Symposium proposed to International Society of the Learning Sciences annual meeting, 2023

Hennessy Elliott, C., Nixon, J., Bush, J.B., & Recker, M. (2023) Teachers' Learning to Support Students During Science Inquiry: Managing Student Uncertainty in a Debugging Context. Long Paper submitted to be presented at the annual meeting of the International Conference of the Learning Sciences, Montreal, CA. 2023.

COURSES TAUGHT

Sensor Immersion: Using Programmable Sensors to Conduct Locally Relevant Scientific Investigations

Problem Based Instruction in Secondary Mathematics

Mathematics for Elementary School Educators

Teaching and Learning K-12 Statistics and Probability

Teaching and Learning K-12 Algebraic Thinking

Introduction to teaching CS with AgentCubes Online

AP Calculus

Algebra II

Environmental Geology

Robotics for Beginners

SERVICE

Executive Committee – NSF National AI Institute for Student-AI Teaming: 2021-present

Community Cycles – Community Cycles, Boulder, CO: 2022-present

United Government of Graduate Students – School of Education assembly representative: 2016-2019

Volunteer Tutor – I Have A Dream Foundation of Boulder County: 2018-2019