

Rachel Arnold

CONTACT INFORMATION

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Virginia Tech
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EMPLOYMENT

Mathematics Collegiate Assistant Professor, **Virginia Tech** August 2017 – Present

Mathematics GTA Coordinator, **Virginia Tech** August 2014 – Present

Consulting Mathematician, **Digital Bazaar, Inc.** January 2018 – Present

Mathematics Instructor, **Virginia Tech** August 2012 – August 2017

EDUCATION

Virginia Tech, Blacksburg, Virginia August 2003 – May 2012

- Ph.D. in Mathematics
Advisor: Dr. Peter Haskell
Awarded May 2012
- M.S. in Mathematics
Advisor: Dr. Peter Haskell
Awarded May 2008
- B.S. in Mathematics
Summa Cum Laude
Awarded May 2006

RESEARCH INTERESTS

Undergraduate Mathematics Education; Mathematics Graduate Student Teacher Professional Development; Algebraic Topology; Asynchronous Consensus.

JOURNAL ARTICLES

- J4. Norton, A., Arnold, R., Kokushkin, V., & Tiraphatna, M. (2022). Addressing the cognitive gap in mathematical induction. *International Journal of Research in Undergraduate Mathematics Education*, 1-27. DOI: [10.1007/s40753-022-00163-2](https://doi.org/10.1007/s40753-022-00163-2).
- J3. Arnold, R., & Longley, D. (2021). Continuity: A deterministic Byzantine fault tolerant asynchronous consensus algorithm. *Computer Networks*, 199, 108431. DOI: [10.1016/j.comnet.2021.108431](https://doi.org/10.1016/j.comnet.2021.108431).
- J2. Arnold, R. & Longley, D., Zero-Knowledge Proofs Do Not Solve the Privacy-Trust Problem of Attribute-Based Credentials, *IEEE Communications Standards Magazine*, Dec, 2019. DOI: [10.1109/MCOMSTD.001.1900027](https://doi.org/10.1109/MCOMSTD.001.1900027).
- J1. Haider, M.A., Olander, J.E., Arnold, R.F., Marous, D.R., McLamb, A.J., Thompson, K.C., Woodruff, W.R., & Haugh, J.M. (2011). A phenomenological mixture model for biosynthesis and linking of cartilage extracellular matrix in scaffolds seeded with chondrocytes, *Biomechanics and Modeling in Mechanobiology*, 10, 915-924. DOI: [10.1007/s10237-010-0282-y](https://doi.org/10.1007/s10237-010-0282-y).

REFEREED CONFERENCE PROCEEDINGS

- P3. Norton, A. & Arnold, R. (2019), Meeting the cognitive demands of proof by induction: the case of Ben. In S. Otten, A. G.. Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.), *Proceedings of the 41st Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 887-891). St. Louis, MO: University of Missouri.

- P2. Norton, A., & Arnold, R. (2017), Logical implication as the object of mathematical induction. In E. Galindo & J. Newton, (Eds.), *Proceedings of the 39th Annual Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 745-748). Indianapolis, IN: Hoosier Association of Mathematics Teacher Educators.
- P1. Arnold, R., & Norton, A. (2017), Mathematical actions, mathematical objects, and mathematical induction. In A. Weinberg, C. Rasmussen, J. Rabin, M. Wawro, & S. Brown (Eds.), *Proceedings of the 20th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 53-66). San Diego, California. (ISSN 2474-9346).

THESES

- T2. Arnold, R. F. The Discrete Hodge Star Operator and Poincaré Duality, *PhD Thesis*, Virginia Tech, May 2012.
- T1. Arnold, R. F. Complex Analysis on Planar Cell Complexes. *Master's Thesis*, Virginia Tech, May 2008.

TEACHING
HANDBOOKS

- H2. Arnold, R. *Math 1226 Teaching Handbook*. [Internet]. Blacksburg, VA; 2019.
- H1. Arnold, R. *Math 1225 Teaching Handbook*. [Internet]. Blacksburg, VA; 2019.

COURSE
TEXTBOOK

- B1. Arnold J., Arnold R., & Rogers R. *An Introduction to Mathematical Proofs*. Virginia Tech Mathematics Department. 2018.

EXTERNAL
GRANTS

National Science Foundation, 2022 – Present
Improving Undergraduate STEM Education
Addressing Cognitive and Instructional Challenges in Introductory Proofs Courses: the Gateway to Advanced STEM Studies (DUE-2141626), R. Arnold (PI), A. Norton (co-PI),
 Total Award: \$300,000.

INTERNAL
GRANTS

Virginia Tech Center for Excellence in Teaching and Learning, 2019
Instructional Innovation Grant
Increasing the Amount and the Quality of Student Talk in Engineering Calculus Classes,
 R. Arnold (PI), Total Award: \$1,794.

AWARDS

- Alumni Award for Excellence in Teaching** 2022
 Virginia Tech
- Academy for Teaching Excellence** 2022
 Virginia Tech, *inducted member*
- Certificate of Teaching Excellence** 2021
 Virginia Tech, College of Science
- Favorite Faculty Curiosity Award** 2018
 Virginia Tech, *student nominated*
- Instructor of the Year** 2017
 Virginia Tech, Mathematics Department
- Favorite Faculty** 2013, 2015–17
 Virginia Tech, *student nominated*
- Graduate Student Teaching Excellence Award,** 2010
 Virginia Tech
- Graduate Teaching Assistant of the Year** 2009
 Virginia Tech, Mathematics Department

Outstanding Senior – Traditional Option

2006

Virginia Tech, Mathematics Department

RECOGNITIONS	<p>Thank a Teacher 2017–22 Virginia Tech, <i>recognition by students</i></p>
CONFERENCE TALKS BY REFEREED SUBMISSION	<p>Norton, A. & Arnold, R. (2019, November). <i>Meeting the Cognitive Demands of Proof by Induction: the Case of Ben</i>. 41st Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, St. Louis, MO.</p> <p>Norton, A. & Arnold, R. (2017, October). <i>Logical Implication as the Object of Mathematical Induction</i>. 39th Meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education, Indianapolis, IN.</p> <p>Arnold, R. & Norton, A. (2017, February). <i>Mathematical Actions, Mathematical Objects, and Mathematical Induction</i>. 20th Annual Conference on Research in Undergraduate Mathematics Education, San Diego, CA.</p>
INVITED TALKS	<p>Arnold, R. & Norton, A. (2021, March). <i>The Cognitive Gap in Mathematical Induction</i>. Invited colloquium given at James Madison University via Zoom.</p> <p>Arnold, R. (2021, March). <i>The Cognitive Gap in Mathematical Induction</i>. Keynote Speaker for Virginia Tech Chapter of the Association for Women in Mathematics 50th Anniversary Research Days via Zoom.</p> <p>Arnold, R. (2014, November & 2013, October) <i>Balancing Graduate Life and Study</i>. Panel Member for Mathematics GTA Professional Development Seminar at Virginia Tech, Blacksburg, VA.</p> <p>Arnold, R. (2011, August). <i>Tips from an Experienced Award-Winning GTA</i>. Invited speaker at the Virginia Tech Graduate School GTA Workshop, Blacksburg, VA.</p>
GUEST LECTURES	<p><i>Confidence in Teaching and Learning</i>, Fall 2010, 2011, 2016–21, Spring 2020–22 Virginia Tech, GRAD 5004 GTA Training Workshop</p> <p><i>The Utility of Mathematics</i>, Fall 2019, 2021 Virginia Tech, MATH 1004 Discovering Mathematics</p> <p><i>Majoring in Mathematics: the Traditional Option</i>, Fall 2017–18 Virginia Tech, MATH 1004 Discovering Mathematics</p>
WORKSHOPS	<p>The Mathematical Association of America’s College Mathematics Instructor Development Source (CoMInDS)</p> <ul style="list-style-type: none"> • National Workshop at University of Tennessee, Knoxville, TN March 2019 <i>Instructional design session co-leader</i> • National Workshop at University of Maine, Orono, ME June 2016 <i>Participant</i> • Regional Workshop at Duke University, Durham, NC February 2016 <i>Invited collaborator</i> <p>Virginia Mathematics Summit</p> <ul style="list-style-type: none"> • Virginia State University, Petersburg, VA April 2016 <i>Virginia Tech representative</i>

ADVISING

Graduate Student Advising at Virginia Tech

Ashlyn McDonald, Mathematics (<i>M.S. committee member</i>)	Spring 2022 – Present
Michael Kepler, Electrical Engineering (<i>Ph.D. committee member</i>)	Fall 2019 – Spring 2021
Vladislav Kokushkin, Mathematics (<i>research project advisor</i>)	Spring 2018 – Present
Funded under NSF: IUSE DUE-2141626 Summer 2022 & Fall 2022	
Matthew Park, Mathematics (<i>research project advisor</i>)	Fall 2021 – Present
Funded under NSF: IUSE DUE-2141626 Summer 2022 & Spring 2023	
Marcie Tiraphatna, Mathematics (<i>research project advisor</i>)	Spring 2018–22
~50/year Mathematics Graduate Teaching Assistants	Fall 2014 – Present
<i>(Supervisor & providor of professional development for teaching)</i>	

Undergraduate Student Advising at Virginia Tech

Mathematics Majors in the Traditional Option	Fall 2012 – Spring 2018
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TEACHING

Virginia Tech

Advanced Calculus (Intro Real Analysis)	Fall 2018–21, Spring 2014,2017–22
Intro to Proofs	Fall 2012,2015–17,2021, Spring 2015,2018,2022
Intro to Linear Algebra	Fall 2016,2017, Spring 2016
Intro Multivariable Calculus	Fall 2015, Spring 2009,2013,2015
Honors Intro Multivariable Calculus	Spring 2010–11
Calculus of a Single Variable II	Fall 2008,2014, Spring 2012,2013
Calculus of a Single Variable I	Fall 2007,2009,2012,2013

PROFESSIONAL
DEVELOPMENT
INNOVATIONS
& LEADERSHIP

Virginia Tech

Designed & led VT Math GTA Professional Development program	2014 – Present
Hosted 2-week professional writing challenge for Math GTAs & Faculty	2021, 2022
Authored Math 1225-6 Teaching Handbooks to accelerate the rate at which novice teachers gain pedagogical content knowledge for teaching calculus	2019
Co-designed & co-led New VT Math Faculty 2-Week Training Program	2019
Founded & chaired Faculty Mentor Committee for new math GTAs	2016 – Present
Co-founded weekly teachers’ meetings for Math 1225-6 teachers	2016

National

MAA College Mathematics Instructors Development Source	2019
<i>Workshop co-designer & co-leader of 2 sessions on instructional design</i>	

CURRICULUM
& COURSE
DESIGN

Revised Virginia Tech Mathematics GTA Teaching Certification Program	2021 – Present
Conducted Math Education Research & produced instructional tasks for Virginia Tech’s Math 3034 Intro to Proofs course	2016 – Present
Designed & led 6-7 professional development seminars for Virginia Tech Mathematics GTAs per semester	2015 – Present
Revised & became co-author of textbook commonly used by Virginia Tech’s Math 3034 Intro to Proofs teachers	2015 – Present
Created YouTube lectures for Virginia Tech’s Math 3224 Advanced Calculus	2020
Designed Virginia Tech Mathematics GTA Peer Mentor Program via a 3-week seminar with GTA input	2017
Designed & led Teaching for Robust Understanding (TRU) Math 7-week Seminar for GTAs on Alan Schoenfeld’s Five Dimensions of Mathematically Powerful Classrooms	2016

Co-chaired revision of Virginia Tech’s engineering calculus sequence 2012–14
Team lead for creation of Math 1225-6

Co-created Virginia Tech’s Da Vinci Living-Learning Community Math Seminar 2012–13

Team member for revision of Virginia Tech’s life science calculus sequence 2013
Funded by state of Virginia 4VA Initiative

PROFESSIONAL
SERVICE

Department

Mathematics GTA Coordinator Fall 2014 – Present

Virginia Tech Academy for Teaching Excellence (*member*) Spring 2022 – Present

Mathematics Department Undergraduate Program Committee (*member*) Fall 2013 – Present

Faculty Mentor Committee for GTAs (*creator & chair*) Fall 2016 – Present

Mathematics GTA Teaching Certification Committee (*chair*) Fall 2015 – Present

Common Time Final Exam Committees (*writer, editor, & proofreader*) Fall 2012 – Spring 2019
 Math 1205-6, 1226, 2204, & 2114

Mathematics Instructor Search Committee (*member*) May 2018

Undergraduate Advisor (Mathematics - Traditional Option) Fall 2012 – Spring 2018

Engineering Calculus I Course Coordinator Fall 2012 – Spring 2014

Engineering Calculus Sequence Revision Committee (*co-chair*) Fall 2012–14

University

Faculty Scholar of the Virginia Tech Academy for GTA Excellence Spring 2018 – Present

Designed & led GRAD 5004 GTA Workshop Fall 2010,2011,2015-2021, Spring 2020-2022
 Phase 2 seminar session on the role of
 confidence in teaching & learning

Virginia’s Community Colleges Math Pathways Project Fall 2016 - Summer 2017
Virginia Tech Representative for Calculus

National

Judge for Mid-Atlantic Undergraduate Research Conference (MAURC) March 2021

Co-designed & Co-led two sessions on instructional design at MAA
 College Mathematics Instructor Development Source National Workshop
University of Tennessee, Knoxville March 2019

Peer-reviewed proposals for the North American Chapter of the
 International Group for the Psychology of Mathematics Education Conference March 2019

Reviewed book proposal for Schoenfeld, A., Fink, H., & Zuñiga-Ruiz, S. 2022
*Helping Students Become Powerful Mathematics Thinkers: Case Studies
 of Teaching for Robust Understanding.* Routledge

Reviewed manuscript & contributed edits for Kelton, S. (2020). *A Beginner’s
 Guide to Teaching Mathematics in the Undergraduate Classroom.* Routledge 2019

OUTREACH

Developer of new website for Virginia Tech Math Graduate Students 2022 – Present
(Under construction)

Keynote speaker at Virginia Tech’s Chapter of the Association for Women
 in Mathematics 50th Anniversary Research Days March 2021

Guest lecturer for Virginia Tech’s Math 1004 Discovering Mathematics 2017–19,2021
First-Year Experience for mathematics majors

Virginia Tech’s SWIMM: Supporting Women in Mathematics through Mentoring
 Women’s Month Luncheon March 2019

Nominator of recipient of *2017 Virginia Tech Graduate Student Teaching
 Excellence Award* 2017

PROFESSIONAL
TRAINING

Compliance: Title IX/Policy 1025/VAWA	March 2022
Virginia Tech TLOS <i>Tech Talks: Living in Canvas</i>	January 2022
Virginia Tech TLOS <i>Foundations of Online Teaching</i>	December 2021
State of Virginia: Civilian Response for Active Shooter Events	December 2021
Virginia Tech TLOS <i>Cyber Security</i>	November 2021
FERPA Training	September 2021
Virginia Tech Strategic Affairs <i>Diversity: Inclusion in the Modern Workplace</i>	January 2021
Virginia State Employee <i>Safety and Disaster Awareness Training</i>	January 2021
Collaborative Institutional Training Initiative (CITI) <i>Human Subjects Research Basic Course</i>	January 2021