

## Joseph E. Antonides

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### Education

2018 – 2022

#### Ph.D. in Mathematics Education

The Ohio State University, Columbus, OH, USA

- Dissertation: “A Cognition-Based Analysis of Undergraduate Students’ Reasoning about the Enumeration of Permutations”
- Committee: Michael T. Battista (chair), Azita Manouchehri (co-chair), Erik S. Tillema, Matthew Kahle

2015 – 2017

#### M.M.S. in Mathematics

The Ohio State University, Columbus, OH, USA

- Master’s Thesis: “An Analysis of the Order of Limit-Related Topics as Presented in Six Elementary Calculus Textbooks”
- Committee: James Fowler (chair), Michael T. Battista (co-chair)

2011 – 2015

#### B.A. in Mathematics

Susquehanna University, Selinsgrove, PA

- Undergraduate Thesis: “On Long-Square-Free Words and Long-Repetition-Free 2-Colorings of Graphs”
- *Summa Cum Laude* with Departmental Honors in Mathematics

### Professional Experience

08/2022 –  
Present

**Postdoctoral Associate**, Department of Mathematics, Virginia Tech, Blacksburg, VA (Postdoctoral Mentor: Anderson Norton)

Aug. 2019 –  
May 2022

**Graduate Teaching Associate** (Student-Teacher Field Supervisor), Middle Grades Licensure Program, College of Education and Human Ecology, The Ohio State University, Columbus, OH

Aug. 2018 –  
May 2021

**Course Coordinator**, Department of Mathematics, The Ohio State University, Columbus, OH

Jan. 2018 –  
Aug. 2020

**Adjunct Faculty Member**, Department of Mathematics, Columbus State Community College, Columbus, OH

Aug. 2018 –  
July 2019

**Graduate Research Associate**, College of Education and Human Ecology, The Ohio State University, Columbus, OH

May 2017 – **Part-Time Lecturer**, Department of Mathematics, The Ohio State  
 Aug. 2018 University, Columbus, OH

July 2015 – **Graduate Teaching Associate**, Department of Mathematics, The Ohio State  
 May 2017 University, Columbus, OH

## Other Professional Training

2023 Completion of SafeZone Course I  
 2022 Completion of Training Module *Diversity, Equity, and Inclusion: Road to Cultural Competency*  
 2022, 2024 Completion of Training Module *READ: Respect, Equity, and Anti-Discrimination*  
 2022 Completion of Training Module *Civilian Response for Active Shooter Events*  
 2022, 2023, 2024 Completion of Training Module *State of Virginia Employee Safety and Disaster Awareness*

## Summary of Research Interests

My research maintains three interrelated research agendas. First, I am interested in how students construct mathematical concepts, particularly with the domains of combinatorics, geometry, and logic. To frame this aspect of my work, I draw heavily on constructivist theories, especially action-object theories and theories of abstraction. Second, I am interested in how students' constructions of mathematical concepts can be supported through equitable, inquiry-oriented instruction, particularly at the undergraduate level. I build, test, and refine learning trajectories (LTs) where qualitatively-distinct ways of thinking about mathematical ideas are linked to specific instructional tasks and strategies hypothesized to support student thinking about that mathematical idea. Third, I am interested in comparing and unifying compatible theoretical perspectives on students' mathematical thinking. In doing so, I aim to (a) build bridges across differing perspectives and potentially leverage each theory to the enhancement of the other, and (b) apply unified theoretical perspectives to develop increasingly accurate and reliable explanations of students' reasoning.

## Publications

Note: \* and † indicate scholarly work conducted with graduate and undergraduate students, respectively.

### *Peer-Reviewed Journal Articles*

**Antonides, J.**, Norton, A., & Arnold, R. (2024). Linking structures across logic and space: The role of Euler diagrams. *For the Learning of Mathematics*, 44(2), 2-8.

Tillema, E. S., & **Antonides, J.** (2024). Units coordination, combinatorial reasoning, and the multiplication principle: The case of Ashley, an advanced stage 2 college student. *Investigations in Mathematics Learning*, 16(3), 243-2626.

<https://doi.org/10.1080/19477503.2024.2319004>

**Antonides, J., & Battista, M. T.** (2022). A learning trajectory for enumerating permutations: Applying and elaborating a theory of levels of abstraction. *Journal of Mathematical Behavior*, 68, 101010. <https://doi.org/10.1016/j.jmathb.2022.101010>

**Antonides, J., & Battista, M. T.** (2022). Spatial-temporal-enactive structuring in combinatorial enumeration. *ZDM Mathematics Education*, 54(4), 795-807. <https://doi.org/10.1007/s11858-022-01403-0>

Zyromski, B., Baker, E., Betters-Bubon, J., Dollarhide, C., & **Antonides, J.** (2020). Adverse childhood experiences: A 20-year content analysis of American Counseling Association and American School Counselor Association journals. *Journal of Counseling and Development*, 98(4), 351-362. <https://doi.org/10.1002/jcad.12338>

### ***Peer-Reviewed Journal Articles (In Review)***

**Antonides, J., Norton, A., Battista, M. T., & Zwanch, K.** (revision in review). Coordinating units coordination with spatial structuring: Toward enhanced second-order models of students' spatial enumerations. *Cognition and Instruction*.

Arnold, R., Mitchell, C.\*, **Antonides, J., & Norton, A.** (in review). Reinventing the logic of mathematical induction: Closing the gap between quasi-induction and formal proof by induction. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies*.

### ***Peer-Reviewed Journal Articles (In Progress)***

**Antonides, J., & Norton, A.** (in progress). Extending unit transformation graphs to spatial measurement. *Journal for Research in Mathematics Education*.

**Antonides, J., Norton, A., & Arnold, R.** (in progress). Treatment of logical implications as an object: The case of Zeke. *International Journal of Research in Undergraduate Mathematics Education*.

Norton, A., **Antonides, J., Arnold, R., & Kokushkin, V.** (in progress). Logical implications as mathematical objects: Characterizing epistemological obstacles experienced in introduction to proofs courses. *Journal of Mathematical Behavior*.

Battista, M. T., & **Antonides, J.** (in progress). Progressive, adaptive, learning-progression-based concreteness fading in mathematics teaching. *Educational Studies in Mathematics*.

Arnold, R., Kokushkin, V., Norton, A., & **Antonides, J.** (in progress). Students' treatment of the negation of a logical implication. *Journal for Research in Mathematics Education*.

Tillema, E. S., Liu, J., Ataide Pinheiro, W., **Antonides, J., & Jeon, M.** (in progress). Expanding Steffe's reorganization hypothesis: Combinatorics problems a constructive resource for volumes of fractional dimension. *Journal of Mathematical Behavior*.

### ***Publications in Peer-Reviewed Undergraduate Research Journals***

**Antonides, J.,** Kiers, C., & Yamzon, N. (2017). On the long-repetition-free 2-colorability of trees. *Rose-Hulman Undergraduate Mathematics Journal*, 18(1), 262-269.

Basu, S., O'Riley, S., Zerbe, C.M., **Antonides, J.,** Gabrielson, M., & Doudt, A.R. (2016). Role of metal ions on quadruplex DNA detection capabilities of porphyrins. *Journal of Undergraduate Chemistry Research*, 15(1), 16-20.

### ***Peer-Reviewed Conference Papers***

**Antonides, J.,** Zwanch, K., Norton, A., & Battista, M. T. (in press). Construction and coordination of spatial units in two dimensions: The case of Jake. To appear in: *Proceedings of the 46<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*. Kent State University.

Arnold, R., Kokushkin, V., Norton, A., & **Antonides, J.** (in press). Students' treatment of the negation of logical implication. To appear in: *Proceedings of the 26th annual conference on Research in Undergraduate Mathematics Education*. University of Nebraska Omaha.

Norton, A., Arnold, R., **Antonides, J.,** & Kokushkin, V. (2023). Epistemological obstacles related to treating logical implications as actions: The case of Mary. In T. Lamberg & D. Moss (Eds.), *Proceedings of the 45th annual meeting of the North American chapter of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 71-80). University of Nevada, Reno.

**Antonides, J.,** & Battista, M. T. (2023). Students' enumerations of tiles within a rotation-based tiling of the plane: Juxtaposing units coordination and spatial structuring perspectives. In S. Cook, B. Katz, & D. Moore-Russo (Eds.), *Proceedings of the 25th annual conference on Research in Undergraduate Mathematics Education* (pp. 385-393). University of Nebraska Omaha.

**Antonides, J.,** & Battista, M. T. (2022). Towards an elaboration of concreteness fading: Reflections on a constructivist teaching experiment. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. S. Strayer, & S. Drown (Eds.), *Proceedings of the 44th annual meeting of the North American chapter of the International Group for the Psychology of Mathematics Education: Critical dissonance and resonant harmony* (pp. 1588-1597). Middle Tennessee State University.

**Antonides, J.,** & Battista, M. T. (2022). Two initial schemes for enumerating permutations: A preliminary report. In S. S. Karunakaran & A. Higgins (Eds.), *Proceedings of the 24th annual conference on Research in Undergraduate Mathematics Education* (pp. 910-916). Boston University.

**Antonides, J.,** & Battista, M. T. (2021). Structuring and enumeration: A preliminary discussion of spatial-temporal-enactive structuring. In D. Olanoff, K. Johnson, & S. M. Spitzer (Eds.), *Proceedings of the 43rd annual meeting of the North American chapter of the*

*International Group for the Psychology of Mathematics Education* (pp. 1874–1878). Philadelphia, PA.

**Antonides, J., & Battista, M. T.** (2021). Case studies on the combinatorial reasoning of two future middle school teachers. To appear in: *Proceedings of the 14<sup>th</sup> International Congress on Mathematical Education (ICME-14)*. East China Normal University.

**Antonides, J., & Battista, M. T.** (2020). Two prospective middle-school teachers reinvent combinatorial formulas: Permutations and arrangements. In A. I. Sacristán, J. Cortés-Zavala, and P. M. Ruiz-Arias (Eds.), *Mathematics across cultures: Proceedings of the 42nd annual meeting of the North American chapter of the International Group for the Psychology of Mathematics Education* (pp. 1108-1116). Cinvestav/AMIUTEM/PME-NA.

### ***Unpublished Works***

**Antonides, J.** (2023). Geometry and measurement for future K-6 teachers: An activities manual. Written for MATH 1624: Geometry for Teachers, Virginia Tech.

**Antonides, J., & Kubota, T.** (2013). Binocular disparity as an explanation for the moon illusion. *arXiv preprint arXiv: 1301.2715*.

## **Presentations and Workshops**

### ***Presentations at National/International Peer-Reviewed Conferences***

Harrington, C., Zwanch, K., Kerrigan, S., Boyce, S., **Antonides, J.**, Tillema, E., & Hackenberg, A. J. (2024, November). *Complex connections: Reimagining pure and applied research in units construction and coordination*. [Conference working group abstract]. The 46<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Cleveland, OH.

Kerrigan, S., Zwanch, K., MacDonald, B., Boyce, S., **Antonides, J.**, Harrington, C., Byerley, C., & Tillema, E. (2024, November). *Complex connections working group: Progress and outcomes*. [Conference working group]. The 46<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Cleveland, OH.

Ortuno, A.<sup>†</sup>, **Antonides, J.**, Bruncati, B.\*, Norton, A., & Arnold, R. (2024, February). *Intro-to-proofs students discuss logical implication and quantification: Themes from one small group*. [Poster presentation]. The 26th annual conference of Research in Undergraduate Mathematics Education (RUME), Omaha, NE.

Arnold, R., Norton, A., Kokushkin, V., **Antonides, J.**, & Park, M.\* (2024, January). *Leveraging research-based instruction in introductory proofs courses*. [Conference workshop presentation]. Joint Mathematics Meetings (JMM), San Francisco, CA.

**Antonides, J., & Tillema, E. S.** (2023, October). *Explicating students' unit structures in combinatorial contexts*. [Poster presentation abstract]. In T. Lamberg & D. Moss (Eds.),

*Proceedings of the 45th annual meeting of the North American chapter of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 871-872). University of Nevada, Reno.

Zwanch, K., Kerrigan, S., MacDonald, B., Boyce, S., **Antonides, J.**, Harrington, C., Byerley, C., & Tillema, E. (2023, October). Complex connections: Reimagining units construction and coordination for teacher noticing and combinatorial reasoning [Conference working group abstract]. In T. Lamberg & D. Moss (Eds.), *Proceedings of the 45th annual meeting of the North American chapter of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 998-1000). University of Nevada, Reno.

**Antonides, J.**, Norton, A., & Arnold, R. (2023, February). Affordances and challenges associated with Euler diagrams as representations of logical implication [Poster presentation abstract]. In S. Cook, B. Katz, & D. Moore-Russo (Eds.), *Proceedings of the 25th annual conference of research in undergraduate mathematics education* (pp. 1385-1387). University of Nebraska Omaha.

**Antonides, J.** (2022, October). *Euler diagrams and logical implication: Potential affordances and challenges*. [Ideas for future research presentation]. The 6th annual Northeastern Conference on Research in Undergraduate Mathematics Education, Virtual.

**Antonides, J.** (2022, February). *Toward understanding and supporting undergraduate students' conceptual progress for enumerating permutations: Findings from a computer-mediated design experiment*. [Poster presentation]. The Ohio State University Hayes Graduate Research Forum, Columbus, OH.

**Antonides, J.**, & Fowler, J. (2021, August). *How are limits commonly introduced in calculus? An examination of six calculus textbooks*. [Conference presentation]. The Mathematical Association of America (MAA) MathFest, Virtual.

**Antonides, J.** (2021, July). *Preliminary levels of sophistication in student reasoning about permutations*. [Brief report presentation]. The International Congress on Mathematical Education, Shanghai, CN (Virtual).

**Antonides, J.** (2020, October). *Toward a learning trajectory for permutations and the elaboration of a theory of abstraction*. [Conference presentation]. The 42nd annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Mazatlán, MX (Virtual).

**Antonides, J.** (2020, February). *Changing the mathematics curricular narrative to reflect transgender and gender non-conforming students' identities and experiences*. [Poster presentation]. The annual meeting of the Association of Mathematics Teacher Educators (AMTE), Phoenix, AZ.

**Antonides, J.**, & Johns, C. (2019, November). *Reflection, case studies, and discourse: Components for training new undergraduate math tutors*. [Poster presentation abstract].

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. 607-608). University of Missouri.

Vakil, J. C., & **Antonides, J.** (2019, September). *Stella is back! Using OSU's new digital math online resource to engage students in cognitively demanding tasks.* [Conference workshop presentation]. The Northern Kentucky University STEM Conferencel, Highland Heights, KY.

**Antonides, J.** (2019). *Current issues and trends in research on career and technical education.* [Poster presentation]. The Ohio State University Education and Human Ecology Research Forum, Columbus, OH.

**Antonides, J.**, Kiers, C., & Yamzon, N. (2014). *Long-square-free graph colorings over 2 colors.* [Poster presentation]. Joint Mathematics Meetings (JMM), Baltimore, MD.

### ***Invited Talks and Other Presentations***

**Antonides, J.** (2024, April). *Undergraduate students' reasoning about permutations.* MATH 5634 (doctoral-level course on research in undergraduate mathematics education), Virginia Tech, Blacksburg, VA. **(Invited)**

**Antonides, J.** (2023, November). *Networking units coordination and spatial structuring to build models of student reasoning about spatial measurement: The case of Jake.* [Research presentation]. Mathematics Education Seminar, School of Mathematical and Statistical Sciences, Arizona State University, Tempe, AZ. **(Invited)**

**Antonides, J.**, Norton, A., Battista, M. T., & Zwanch, K. (2023, October). *Preservice teachers' reasoning about spatial measurement: Networking spatial structuring and units coordination.* [Research presentation] Mathematics Education Research Seminar, Virginia Tech, Blacksburg, VA.

Arnold, R., Norton, A., & **Antonides, J.** (2023, July). *Proofs Project Summer Instructor Workshop.* [Workshop]. Virginia Tech, Blacksburg, VA.

**Antonides, J.**, Norton, A., & Arnold, R. (2023, June). *Euler diagrams as mappings between logical and spatial structures.* [Presentation for NSF Project Evaluator Visit]. Virginia Tech, Blacksburg, VA.

**Antonides, J.** (2023, April). *Learning progressions in mathematics education.* MATH 5624 (doctoral-level course on mathematical knowing and learning), Virginia Tech, Blacksburg, VA. **(Invited)**

**Antonides, J.** (2022, November). *Toward understanding and supporting undergraduate students' reasoning about the enumeration of permutations: Continuing the design cycle.* [Research presentation]. Mathematics Education Research Seminar, Virginia Tech, Blacksburg, VA.

**Antonides, J.** (2022, October). Doctoral proseminar invited panel. [Guest speaker]. Department of Teaching and Learning, The Ohio State University, Columbus, OH. **(Invited)**

**Antonides, J.** (2022, September). *A learning trajectory for enumerating permutations: Applying and elaborating a theory of levels of abstraction*. [Research presentation]. Mathematics Education Research Seminar, Virginia Tech, Blacksburg, VA.

**Antonides, J.** (2022, September). InSTEAMers academic job market invited panel. [Guest speaker]. Department of Teaching and Learning, The Ohio State University, Columbus, OH. **(Invited)**

**Antonides, J.** (2021, September). InSTEAMers academic job market invited panel. [Guest speaker]. Department of Teaching and Learning, The Ohio State University, Columbus, OH. **(Invited)**

**Antonides, J.** (2020, October). Doctoral proseminar invited panel. [Guest speaker]. Department of Teaching and Learning, The Ohio State University, Columbus, OH. **(Invited)**

### ***Invited Conferences and Workshops (Non-Presenter)***

Conference on the Teaching and Learning of Logic (2024, May). Organized by Paul Christian Dawkins, Texas State University, San Marcos, TX.

Specialized Content Knowledge (SCK) Workshop for Mathematics Teacher Educators (2016, November). Organized by Deborah Loewenberg Ball, University of Michigan, Ann Arbor, MI.

## **Teaching Experience**

### ***Virginia Tech***

All courses were taught as the instructor of record. Responsibilities included teaching, writing course syllabi, lesson planning, grading, and maintaining office hours.

- MATH 1214: Preparation for Calculus [Fall 2022]
- MATH 1624: Geometry for Teachers [Spring 2023, Fall 2023, Fall 2024]
- MATH 4626: Mathematics for Secondary Teachers II [Spring 2024]

### ***The Ohio State University***

All courses were taught as the instructor of record unless otherwise marked. Courses marked “GTA” were taught as a Graduate Teaching Associate. Courses marked “TA” were taught as Part-Time Lecturer as the teaching assistant for the course. In all roles, responsibilities included lesson planning, teaching, grading, tutoring in the department tutoring center, and maintaining regular office hours.

### **Department of Mathematics**



- MATH 1075: Precollege Mathematics II [Summer 2016 (GTA); Summer 2017; Autumn 2017 ]
- MATH 1116: Quantitative Reasoning [Spring 2018]
- MATH 1125: Mathematics for Elementary Teachers I [Autumn 2017 (TA); Spring 2018 (TA)]
- MATH 1126: Mathematics for Elementary Teachers II [Spring 2017 (GTA)]
- MATH 1151: Calculus I [Autumn 2015 (GTA); Autumn 2016 (GTA)]
- MATH 1152: Calculus II [Spring 2016 (GTA)]

### **Office of Diversity and Inclusion, Bridge-to-College Mathematics Course Teaching**

Responsibilities included lesson planning and teaching, both relevant mathematics content and other skills to prepare students for success in college.

- Preparation for MATH 1050: Precollege Mathematics I [Summer 2018]
- Preparation for MATH 1075: Precollege Mathematics II [Summer 2017]

### **Department of Teaching and Learning**

All courses were taught as a Graduate Teaching Associate. Responsibilities included teaching, lesson planning, grading lesson plans, conducting classroom observations of teaching, and facilitating student teachers' mid-semester and end-of-semester evaluations of progress (in conjunction with cooperating teachers).

- EDUTL 3189: Field Experience [Spring 2022]
- EDUTL 4189.02: Advanced Field Placement: Middle-Childhood Education [Autumn 2019; Autumn 2020; Autumn 2021]
- EDUTL 5195.02: Reflective Seminar: Middle-Childhood Education [Spring 2020; Spring 2021; Spring 2022]

### ***Columbus State Community College***

All courses were taught as the instructor of record. Responsibilities included teaching, writing course syllabi, lesson planning, grading, and maintaining office hours.

- MATH 1025: Quantitative Literacy [Spring 2018]
- MATH 1125: Conceptual Mathematics for Teachers I [Summer 2019; Summer 2020]
- MATH 1151: Calculus I [Spring 2018; Summer 2018]

## **Awards, Grants, and Honors**

### ***Grant Proposals Submitted, Awaiting Funding Decision***

2024-2027      Supporting Teachers to Experience Mathematics as Unified and Personally Powerful (STEMUPP). National Science Foundation, IUSE: EDU. PI, Anderson Norton. Co-PI, Joseph Antonides. (\$399,341)

### ***Current and Prior Awards***

2022-2024      Postdoctoral Start-Up Travel Fund, Department of Mathematics, Virginia Tech. (\$13,000)

2022            STEAM Travel Grant, Department of Teaching and Learning, The Ohio State University. (\$500)

2022	Office of Research Travel Grant, College of Education and Human Ecology, The Ohio State University. (\$250)
2021	Career Development Grant, Council of Graduate Students, The Ohio State University. (\$326.56)
2021	Harry C. Moores Scholarship. (\$1,282)
2020	Joe Crosswhite Award in Mathematics Education. (\$2,000)
2019	Joe Crosswhite Award in Mathematics Education. (\$1,000)
2019	Office of Research Travel Grant, College of Education and Human Ecology, The Ohio State University. (\$250)

### ***Honors***

2016	First-Year Graduate Teaching Associate Award, Department of Mathematics, The Ohio State University
2015	Jack Reade Mathematical Sciences Award, Susquehanna University

### **Service Activities**

#### ***Reviewing Service: Funding Agencies***

- National Science Foundation, 2023

#### ***Reviewing Service: Journals***

- *Journal for Research in Mathematics Education*
- *Cognition and Instruction*
- *Mathematical Thinking and Learning*
- *The Mathematics Educator*
- *ZDM Mathematics Education*
- *International Journal of Mathematical Education in Science and Technology*
- *School Science and Mathematics*
- *Kentucky Journal of Mathematics Teacher Education*

#### ***Reviewing Service: Conferences***

- PME-NA (North American Chapter of the International Group for the Psychology of Mathematics Education)
- RUME (Special Interest Group of the MAA on Research on Undergraduate Mathematics Education)
- Association of Mathematics Teacher Educators
- International Congress on Mathematical Education

#### ***Leadership Service: Conferences***

- PME-NA Working Group Co-Organizer, Complex Connections (Units Coordination), 2023-Present
- PME-NA Strand Leader, Geometry and Measurement, 2023
- PME-NA Research Report and Brief Research Report Session Chair, 2020, 2022
- PME-NA Steering Committee, Graduate Student Member (Elected), 2019-2020

### ***Departmental and College-Level Service***

#### **Virginia Tech, Department of Mathematics**

- Proof-Reader, MATH 1214 Common Time Exams (2020)
- Contributed toward developing MATH 1614/1624 as courses that satisfy components of the Pathways General Education curriculum

#### **The Ohio State University, Department of Mathematics**

- Course Development Committee Member for MATH 1120, 1121: Precalculus with Review (2021)

### **Memberships in Professional Organizations**

- National Council of Teachers of Mathematics (NCTM)
- Mathematical Association of America (MAA)
- North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA)
- MAA Special Interest Group on Research on Undergraduate Mathematics Education (RUME)