

## MEGAN WAWRO

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### EDUCATION

University of California, San Diego & San Diego State University	2007-2011	Ph.D.	Mathematics and Science Education
Miami University	2003-2005	M.A.	Mathematics
Cedarville University	1996-2000	B.A.	Mathematics

### EMPLOYMENT

2016-present	Virginia Tech, Associate Professor, Department of Mathematics, Blacksburg, VA
2011-2016	Virginia Tech, Assistant Professor, Department of Mathematics, Blacksburg, VA
2007-2011	San Diego State University, Graduate Research Assistant, Department of Mathematics and Statistics, San Diego, CA
2005-2007	Miami University, Visiting Instructor, Department of Mathematics and Statistics, Oxford, OH
2005-2007	Summer in Switzerland program at Leysin American School, Mathematics Teacher and Residential Life Coordinator ('07), Leysin, Switzerland
2003-2005	Miami University, Graduate Teaching Assistant, Department of Mathematics and Statistics, Oxford, OH
2001-2003	Institut auf dem Rosenberg, Mathematics Teacher, St. Gallen, Switzerland
2000-2001	Portsmouth East High School, Mathematics and Art Teacher, Portsmouth, OH

### AWARDS, PRIZES, AND RECOGNITIONS

Presidential Early Career Award for Scientists and Engineers (PECASE) recipient, 2019  
Affiliate Faculty, Virginia Tech School of Education Faculty of Teaching and Learning, 2014-present  
Best Paper Award for the Sixteenth Annual Conference on Research in Undergraduate Mathematics Education (RUME) with David Plaxco, 2013.  
STaR (Service, Teaching, and Research) Fellow, 2012. The STaR Project is an NSF-funded networking and mentoring program for new faculty in math education.

### PUBLICATIONS

#### Papers in refereed journals

Serbin, K.S., Sanchez-Robayo, B., Truman, J., Watson, K., & Wawro, M. (2019). *Characterizing students' conceptual and procedural knowledge of the characteristic equation*. Manuscript submitted for publication.

- Wawro, M., Watson, K., & Christensen, W. (2019). *Students' Meta-Representational Competence with matrix notation and Dirac notation*. Manuscript submitted for publication.
- Wawro, M., Watson, K., & Zandieh, M. (2019). Student understanding of linear combinations of eigenvectors. *ZDM The International Journal on Mathematics Education*. DOI 10.1007/s11858-018-01022-8
- Andrews-Larson, C., Wawro, M., & Zandieh, M. (2017). A hypothetical learning trajectory for conceptualizing matrices as linear transformations. *International Journal of Mathematical Education in Science and Technology*, 48(6), 809-829.
- Zandieh, M., Wawro, M., & Rasmussen, C. (2017). An example of inquiry in linear algebra: The roles of symbolizing and brokering. *PRIMUS*, 27(1), 96-124.
- Wawro, M. (2015). Reasoning about solutions in linear algebra: The case of Abraham and the Invertible Matrix Theorem. *International Journal of Research in Undergraduate Mathematics Education*, 1(3), 315-338.
- Plaxco, D., & Wawro, M. (2015). Analyzing student understanding in linear algebra through mathematical activity. *Journal of Mathematical Behavior*, 38, 87-100.
- Rasmussen, C., Wawro, M., & Zandieh, M. (2015). Examining individual and collective level mathematical progress. *Education Studies in Mathematics*, 88(2), 259-281.
- Selinski, N., Rasmussen, C., Wawro, M., & Zandieh, M. (2014). A methodology for using adjacency matrices to analyze the connections students make between concepts: The case of linear algebra. *Journal for Research in Mathematics Education*, 45(5), 550-583.
- Wawro, M. (2014). Student reasoning about the invertible matrix theorem in linear algebra. *ZDM The International Journal on Mathematics Education*, 46(3), 1-18.
- Wawro, M., Rasmussen, C., Zandieh, M., Sweeney, G., & Larson, C. (2012). An inquiry-oriented approach to span and linear independence: The case of the Magic Carpet Ride sequence. *PRIMUS*, 22(8), 577-599.
- Becker, N., Rasmussen, C., Sweeney, G., Wawro, M., Towns, M., & Cole, R. (2012). Reasoning using particulate nature of matter: An example of a sociochemical norm in a university-level physical chemistry class. *Chemistry Education Research and Practice*, 14, 81-94.
- Cole, R., Becker, N., Towns, M., Sweeney, G., Wawro, M., & Rasmussen, C. (2012). Adapting a methodology from mathematics education research to chemistry education research: Documenting collective activity. *International Journal of Science and Mathematics Education*, 10, 193-211.
- Nemirovsky, R., Rasmussen, C., Sweeney, G., & Wawro, M. (2012). When the classroom floor becomes the complex plane: addition and multiplication as ways of bodily navigation. *Journal of the Learning Sciences*, 21(2), 287-323.
- Wawro, M., Sweeney, G., & Rabin, J. M. (2011). Subspace in linear algebra: Investigating students' concept images and interactions with the formal definition. *Educational Studies in Mathematics*, 78(1), 1-19.

### **Book Chapters**

- Plaxco, D., Zandieh, M., & Wawro, M. (2018). Stretch directions and stretch factors: A sequence intended to support guided reinvention of eigenvector and eigenvalue. In S. Stewart, C. Andrews-Larson, A. Berman, & M. Zandieh (Eds.), *Challenges In Teaching Linear Algebra* (pp. 175-192), ICME-13 Monographs. Springer, Cham.
- Rasmussen, C., & Wawro, M. (2017). Post-calculus research in undergraduate mathematics education. In J. Cai, (Ed.), *The compendium for research in mathematics education* (pp. 551-579). Reston VA: National Council of Teachers of Mathematics.

- Wawro, M. (2016). Finding synergy among research, teaching, and service: An example from mathematics education research. In J. Dewar, P. Hsu, & H. Pollatsek (Eds.), *Mathematics Education: A Spectrum of Work in Mathematical Sciences Departments* (pp. 135-145). Springer International Publishing.
- Wawro, M., Rasmussen, C., Zandieh, M., & Larson, C. (2013). Design research within undergraduate mathematics education: An example from introductory linear algebra. In T. Plomp, & N. Nieveen (Eds.), *Educational design research – Part B: Illustrative cases* (pp. 905-925). Enschede, the Netherlands: SLO.
- Rasmussen, C., Zandieh, M., & Wawro, M. (2009). How do you know which way the arrows go? The emergence and brokering of a classroom mathematics practice. In W.-M. Roth (Ed.), *Mathematical representation at the interface of body and culture* (pp. 171-218). Charlotte, NC: Information Age Publishing.

### Other Publications

- Trigueros, M., & Wawro, M. (in press). Linear Algebra Teaching and Learning. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education*. Springer, Cham.
- Wawro, M., Ellis, J., & Soto-Johnson, H. (2014). MPWR: Mentoring and partnerships for women in RUME. *Association for Women in Mathematics Newsletter*, 44(5), 20-23.

### Papers in refereed conference proceedings

- Wawro, M., Watson, K., & Christensen, W. (2019). Student reasoning about eigenvectors and eigenvalues from a Resources perspective. In A. Weinberg, D. Moore-Russo, H. Soto, & M. Wawro (Eds.), *Proceedings of the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education* (pp. 654-662), Oklahoma City, OK.
- Serbin, K., Sanchez-Robayo, B., Watson, K., Truman, J., Jiang, S., & Wawro, M. (2019). Characterizing conceptual and procedural knowledge of the characteristic equation. In A. Weinberg, D. Moore-Russo, H. Soto, & M. Wawro (Eds.), *Proceedings of the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education* (pp. 541-548), Oklahoma City, OK.
- Wawro, M., Zandieh, M., & Watson, K. (2018). Delineating aspects of understanding eigentheory through assessment development. In V. Durand-Guerrier, R. Hochmuth, S. Goodchild, & N.M. Hogstad (Eds.), *Proceedings of the Second Conference of the International Network for Didactic Research in University Mathematics (INDRUM 2018, 5-7 April 2018)* (pp. 275-284), Kristiansand, Norway: University of Agder and INDRUM.
- Wawro, M., Watson, K., & Christensen, W. (2017). Meta-representational competence with linear algebra in quantum mechanics. In A. Weinberg, C. Rasmussen, J. Rabin, M. Wawro, and S. Brown (Eds.), *Proceedings of the 20<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education* (pp. 326-337), San Diego, CA.
- Watson, K., Wawro, M., Zandieh, M., & Kerrigan, S. (2017). Knowledge about student understanding of eigentheory: Information gained from multiple choice extended assessment. In A. Weinberg, C. Rasmussen, J. Rabin, M. Wawro, and S. Brown (Eds.), *Proceedings of the 20<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education* (pp. 311-325), San Diego, CA.
- Wawro, M., Watson, K., & Christensen, W. (2017). Meta-representational competence with linear algebra in quantum mechanics. Paper presented at the 10<sup>th</sup> Congress of European Research in Mathematics Education, Dublin, Ireland. In T. Dooley & G. Gueudet, (Eds.), *Proceedings of the Tenth Congress of the European Society for Research in Mathematics Education* (pp. 2282-2289), Dublin, Ireland: DCU Institute of Education and ERME.
- Jaworski, B., Potari, D., Rasmussen, C., Oates, G., Kwon, O.N., Ellis, J., ... Zachariades, T. (2016). *Mathematics Learning and Teaching at University Level*. In Csikos, C., Rausch, A., & Sztányi, J. (Eds.),

*Proceedings of the 40th Conference of the International Group for the Psychology of Mathematics Education, Vol. 1*, pp. 375–404. Szeged, Hungary: PME.

- Wawro, M., & Plaxco, D. (2015). Student understanding of linear independence of functions. *Proceedings of the 9<sup>th</sup> Congress of European Research on Mathematics Education*, Prague, Czech Republic. In K. Krainer, N. Vondrová (Eds.), *Proceedings of the Ninth Congress of the European Society for Research in Mathematics Education (CERME9, 4-8 February 2015)* (pp. 2297-2298). Prague, Czech Republic: Charles University in Prague, Faculty of Education and ERME.
- Wawro, M., & Plaxco, P. (2013). Utilizing types of mathematical activities to facilitate characterizing student understanding of span and linear independence. In S. Brown, G. Karakok, K. H. Roh, and M. Oehrtman (Eds.), *Proceedings of the 16th Annual Conference on Research in Undergraduate Mathematics Education, Volume I* (pp. 1-15), Denver, CO.
- Wawro, M., Larson, C., Zandieh, M., & Rasmussen, C. (2012). A hypothetical collective progression for conceptualizing matrices as linear transformations. In S. Brown, S. Larsen, K. Marrongelle, and M. Oehrtman (Eds.), *Proceedings of the 15th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 1-465 – 1-479), Portland, OR.
- Rasmussen, C., Trigueros, M., Zandieh, M., Possani Espinosa, E., Wawro, M., Sweeney, G., et al. (2010). Building on students' current ways of reasoning to develop more formal or conventional ways of reasoning: The case of linear algebra. In P. Brosnan, D. B. Erchick, & L. Flevares (Eds.), *Proceedings of the 32nd annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1577-1587). Columbus, OH: The Ohio State University.
- Rasmussen, C., Zandieh, M., & Wawro, M. (2010). Brokering as a mechanism for the social production of meaning. In P. Brosnan, D. B. Erchick, & L. Flevares (Eds.), *Proceedings of the 32nd annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 427-434). Columbus, OH: Ohio State University.
- Schwarz, B., Hershkowitz, R., Atzmon, S., Rasmussen, C., Stahl, G., Wawro, M., et al. (2010). Symposium: Social construction of mathematical meaning through collaboration and argumentation. In K. Gomez, L. Lyons, & J. Radinsky (Eds.), *Learning in the Disciplines: Proceedings of the 9th International Conference of the Learning Sciences (ICLS 2010) - Volume 2, Short Papers, Symposia, and Selected Abstracts* (pp. 29-36). International Society of the Learning Sciences: Chicago IL.
- Cole, R., Towns, M., Rasmussen, C., Becker, N., Wawro, M., & Sweeney, G. (2010). Adapting a methodology for documenting collective growth to an undergraduate physical chemistry class. *Proceedings of the 13<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, Raleigh, NC*. Retrieved from: <http://sigmaa.maa.org/rume/crume2010>
- Henderson, F., Rasmussen, C., Sweeney, G., Wawro, M., & Zandieh, M. (2010). Symbol sense in linear algebra. *Proceedings of the 13<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, Raleigh, NC*. Retrieved from: <http://sigmaa.maa.org/rume/crume2010>
- Wawro, M., Sweeney, G., & Rabin, J. M. (2010). Subspace in linear algebra: Investigating students' concept images and interactions with the formal definition. *Proceedings of the 13<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, Raleigh, NC*. Retrieved from: <http://sigmaa.maa.org/rume/crume2010>
- Wawro, M. (2009). Task design: Towards promoting a geometric conceptualization of linear transformation and change of basis. *Proceedings of the 12<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, Raleigh, NC*. Retrieved from: <http://sigmaa.maa.org/rume/crume2009>

### **Editor for Conference Proceedings**

- Weinberg, A., Moore-Russo, D., Soto, H., Wawro, M. (Eds.). (2019). *Proceedings of the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education*, Oklahoma City, OK.

- Weinberg, A., Rasmussen, C., Rabin, J., Wawro, M., & Brown, S. (Eds.). (2018). Proceedings of the 21<sup>st</sup> Annual Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Weinberg, A., Rasmussen, C., Rabin, J., Wawro, M., & Brown, S. (Eds.). (2017). Proceedings of the 20<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Fukawa-Connelly, T., Engelke Infante, N., Wawro, M., & Brown, S. (Eds.). (2016). Proceedings of the 19<sup>th</sup> Annual Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.

## Dissertation

- Wawro, M. (2011). *Individual and Collective Analyses of Student Reasoning regarding the Invertible Matrix Theorem in Linear Algebra* (Advisor: Chris Rasmussen, San Diego State University)

## GRANTS

- National Science Foundation Faculty Early Career Development Program through the Division of Undergraduate Education, *CAREER: An Interdisciplinary Study of Learning: Student Understanding of Linear Algebra in Physics* (DUE-1452889), Megan Wawro (PI), 2015-2020, \$779,686.
- National Science Foundation Transforming Undergraduate Education in STEM, *Collaborative Research: Developing Inquiry-Oriented Instructional Materials for Linear Algebra* (DUE-1245673, 1245796, and 1246083), M. Wawro (lead PI), M. Zandieh and C. Rasmussen (PIs), 2013-2017, Total award \$179,949.
- National Science Foundation, *MPWR 2016 and Beyond: Fostering Sustainable Networks for Women in RUME* (DUE-1553278); J. Ellis (PI), S. Musgrave (co-PI), M. Wawro and E. Thanheiser (senior personnel), 2016-2020, \$199,992. Serving as PI (DUE-1938495) for 2019-2020, \$77,437.
- National Science Foundation Transforming Undergraduate Education in STEM, *MPWR II: Mentoring and Partnerships for Women in RUME* (DUE-1457785), Jessica Ellis (PI); M. Wawro, E. Thanheiser, and S. Musgrave (senior personnel), 2014-2015, \$49,986.
- National Science Foundation Transforming Undergraduate Education in STEM, *MPWR: Mentoring and Partnerships for Women in RUME* (DUE-1352990), M. Wawro (PI), J. Ellis and H. Soto-Johnson (senior personnel), 2013-2014, \$44,148.
- National Science Foundation Robert Noyce Teach Scholarship, *Virginia Teach, Phase II: A Community-Based Approach to Serving Mathematics Students in Need* (DUE-1339947), C. Ulrich (PI), J. Wilkins, B. Kreye, A. Norton, and M. Wawro (co-PIs), 2013-2018, \$800,000.
- National Science Foundation Innovations in Undergraduate STEM Education, *MATH: EAGER Building a mathematical toolkit and motivation for success in the physical and quantitative sciences* (#1544225), J. Sible (PI); K. Drezek, S. Lewis, M. Pleimling, A. Robinson (co-PIs), J. Simonetti, M. Wawro (senior personnel), 2015-2017, \$296,996.
- Virginia Tech Office of the Provost, Faculty Writing Group Grant: *WRITE (Women Researching, Innovating, and Teaching Each other)*, M. Wawro (convener), Carmichael, K., Drape, T., Johnson, E. Labuski, C., Meitner, E., Ovink, S., Reed, A., Robbins, C. K., & Tomer, S., 2019-2020, \$2000.
- Virginia Tech Office of the Provost, Faculty Writing Group Grant: *WRITE (Women Researching, Innovating, and Teaching Each other)*, S. Ovink (convener), Carmichael, K., Drape, T., Johnson, E. Labuski, C., Meitner, E., Reed, A., Robbins, C. K., Tomer, S., & Wawro, M., 2018-2019, \$2000.
- Virginia Tech Center for Innovation in Learning, *Innovation in Undergraduate Mathematics Education: Supporting Student-Centered Instruction*, M. Wawro (PI) and D. Plaxco (co-PI), 2013-2014, \$10,000.
- Virginia Tech International Travel Supplement Grant: \$1,700: 2018 (Norway), 2017 (Ireland), 2016 (France).
- Virginia Tech International Travel Supplement Grant: \$2,000, 2014 (Czech Republic), 2012 (S. Korea).
- AWM-NSF Travel Grant, 2013, \$1500.

Virginia Tech Mentoring Grant, 2011, \$1,500.

## INVITED TALKS

- Wawro, M. (2019, March). *Exploring Teaching and Learning Through Inquiry-Oriented Linear Algebra*. Invited colloquium given at the University of Oslo, Oslo, Norway.
- Wawro, M. (2019, January). *Student reasoning about linear algebra in quantum physics*. Invited colloquium given at the University of Auckland, Auckland, New Zealand.
- Wawro, M. (2018, November). *Exploring teaching and learning through Inquiry-Oriented Linear Algebra*. Invited colloquium given at Northern Illinois University, DeKalb, IL.
- Wawro, M. (2018, November). *Student reasoning about linear algebra in quantum physics*. Invited colloquium given at Northern Illinois University, DeKalb, IL.
- Wawro, M. (2018, October). *Inquiry-Oriented Linear Algebra*. Invited workshop leader for the NSF-sponsored (DUE 1822247) Linear Algebra Workshop on National Pedagogical Initiatives in Linear Algebra, University of Oklahoma, Norman, OK.
- Wawro, M. (2018, May). *Discovering definitions in Inquiry-Oriented Linear Algebra*. Invited Facilitator for a Live Classroom Session for the Inquiry-Based Learning and Teaching Conference, Austin, TX.
- Wawro, M. (2018, April). *Education and professional development of university mathematics teachers*. Invited plenary panelist for the International Network for Didactic Research in University Mathematics (INDRUM), Kristiansand, Norway.
- Wawro, M. (2018, March). *Student reasoning about linear algebra in quantum physics*. Invited colloquium given at Yale University as part of the Yale STEM Center for Teaching and Learning Seminar Series, New Haven, CT.
- Wawro, M. (2018, March). *Exploring teaching and learning through Inquiry-Oriented Linear Algebra*. Invited workshop given at the University of Bridgeport as part of the Yale STEM Center for Teaching and Learning Seminar Series, Bridgeport, CT.
- Wawro, M. (2018, February). *Student reasoning about eigenvectors and eigenvalues*. Invited colloquium given at James Madison University, Harrisonburg, VA.
- Wawro, M. (2017, November). *An inquiry-oriented approach to the teaching and learning of linear algebra*. Invited keynote speaker for the *Wisconsin Section NExT Meeting*. Baraboo, WI.
- Wawro, M. (July, 2017). *Student understanding and symbolization of eigentheory*. Invited plenary speaker for the Physics Education Research Conference, Cincinnati, OH.
- Wawro, M. (2017, July). *Student understanding at the intersection of linear algebra and quantum physics*. Invited plenary speaker for the Transforming Research in Undergraduate STEM Education (TRUSE) Conference, St. Paul, MN.
- Wawro, M. (2017, February). *How to support each other in being successful*. Invited panelist for the 2017 Mentoring and Partnerships for Women in RUME (MPWR) Conference, San Diego, CA.
- Wawro, M. (2016, September). *Research on the learning and teaching of diagonalization and eigentheory*. Invited colloquium given at the Maine Center for Research in STEM Education (RiSE Center), University of Maine, Orono, ME.
- Wawro, M. (2016, April). *Research on the teaching and learning of linear algebra*. Invited colloquium given at West Virginia University, Morgantown, WV.
- Wawro, M. (2016, March). *Research on the teaching and learning of linear algebra*. Invited colloquium given at the University of Delaware, Newark, DE.

- Wawro, M. (2015, August). *Research on the teaching and learning of linear algebra*. Invited colloquium given at the Virginia Tech Mathematics Department, Blacksburg, VA.
- Rasmussen, C., & Wawro, M. (2015, May). *Representing and modeling with vectors*. Invited workshop for the San Diego Mathematics Project “Getting Ready for College Mathematics: Conversations with Math Professors” series for high school teachers, San Diego, CA.
- Wawro, M. (2014, December). *An inquiry-oriented approach to the teaching and learning of linear algebra*. Invited colloquium given at the Colorado State University Mathematics Department, Ft. Collins, CO.
- Wawro, M. (2014, April). *Transitioning from doctoral student to faculty member*. Invited talk given at the Graduate Student, Junior Faculty, and Researcher Mentoring Session at the 2014 NCTM Research Conference, New Orleans, LA.
- Wawro, M., & Plaxco, D. (2014, January). *Utilizing types of mathematical activities to facilitate characterizing student understanding of span and linear independence*. Invited talk given at the Joint Mathematics Meetings [SIGMAA on RUME Session on Research on the Teaching and Learning of Undergraduate Mathematics], Baltimore, MD.
- Wawro, M. (2013, July). *Analyzing student understanding in linear algebra through mathematical activity*. Invited talk given at the 2013 Summer Meeting of the American Association of Physics Teachers [Research in Undergraduate Mathematics Education session], Portland, OR.
- Wawro, M. (2013, April). *Analyzing student understanding in linear algebra through mathematical activity*. Invited colloquium given at the University of North Carolina Charlotte.
- Wawro, M., Sweeney, G., Zandieh, M., & Larson, C. (2011, August). *Designing instruction that builds on students’ ways of reasoning in linear algebra*. SIGMAA on RUME invited workshop at MathFest, Lexington, KY.
- Rasmussen, C., & Wawro, M. (2009). *The Role of Brokers in the Reinvention Process*. Invited workshop at the Second Realistic Mathematics Education Conference, Boulder, CO.

## PRESENTATIONS AT PROFESSIONAL MEETINGS

- Wawro, M., Thompson, J., & Watson, K. (2019). *Student Meanings for Eigenequations in Mathematics and in Quantum Mechanics*. Invited talk given at the Annual Physics Education Research Conference (Parallel Session on Representing student reasoning about math in physics), Cincinnati, OH.
- Wawro, M., Christensen, W., & Watson, K. (2019). Student Reasoning about Eigenvectors and Eigenvalues from a Resources Perspective. Juried Talk given at the Annual Physics Education Research Conference, Cincinnati, OH.
- Wawro, M., Thompson, J., & Watson, K. (2019). *Student Interpretation of Eigenequations in Mathematics and in Quantum Mechanics*. Talk given at the Summer Meeting of the American Association of Physics (Session on PER: Student Content Understanding, Problem-Solving and Reasoning), Cincinnati, OH.
- Wawro, M., Watson, K., & Christensen, W. (2019, February). *Student reasoning about eigenvectors and eigenvalues from a resources perspective*. Paper presented at the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education, Oklahoma City, OK.
- Serbin, K., Sanchez-Robayo, B., Watson, K., Truman, J., Jiang, S., & Wawro, M. (2019, February). Characterizing conceptual and procedural knowledge of the characteristic equation. Paper presented at the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education, Oklahoma City, OK.
- Serbin, K., Storms, R., & Wawro, M. (2019, February). Student reasoning about basis and change of basis in a quantum mechanics problem. Poster presented at the 22<sup>nd</sup> Annual Conference on Research in Undergraduate Mathematics Education, Oklahoma City, OK.

- Wawro, M., Watson, K., & Christensen, W. (2018, August). *Student reasoning about eigenvectors and eigenvalues from a resources perspective*. Poster presented at the Annual Physics Education Research Conference, Washington, DC.
- Christensen, W., Watson, K., & Wawro, M., (2018, August). *Student reasoning about eigenvectors and eigenvalues from a resources perspective*. Contributed talk given at the American Association of Physics Teachers Summer Meeting, Washington, DC.
- Robinson, A., Simonetti, J. H., Richardson, K. L., Esmaili, S., Grimes, M., Lewis, S. N., McConnell, K. D., Pleimling, M. J., Sible, J., Sorenson, K. J., Vengrin, C., & Wawro, M. (2018, August). *Positive attitudinal gains and reduced gender gap in a first year physics experience*. Poster presented at the Annual Physics Education Research Conference, Washington, DC.
- Simonetti, J., Robinson, A., Richardson, K. L., Esmaili, S., Grimes, M., Lewis, S. N., McConnell, K. D., Pleimling, M. J., Sible, J., Sorenson, K. J., Vengrin, C. & Wawro, M. (2018, August). *A first-year experience program in physics*. Poster presented at the 2018 Summer Meeting of the American Association of Physics Teachers, Washington, DC.
- Wawro, M., Zandieh, M., & Watson, K. (2018, April). *Delineating aspects of understanding eigentheory through assessment development*. Paper presented at the International Network for Didactic Research in University Mathematics (INDRUM), Kristiansand, Norway.
- Esmaili, S., Richardson, K. L., Lewis, S. N., Vengrin, C., Sible, J. C., Robinson, A., Pleimling, M., Simonetti, J., Sorenson, K., & Wawro, M. (2018, April.) *The effectiveness of a summer bridge program in integrating math into science instruction*. Poster presented at the 102<sup>nd</sup> meeting of the American Educational Research Association, New York, NY.
- Esmaili, S., Richardson, K. L., Simonetti, J. H., Robinson, A., Sorenson, K., Vengrin, C., Wawro, M., Pleimling, M., & Sible, J. C. (2018, February). *Math, problem solving, and SCALE-UP in an integrated science curriculum and a physics first-year experience program*. Paper presented at the 41st meeting of the Eastern Educational Research Association, Clearwater, FL.
- Wawro, M., Watson, K., & Zandieh, M. (2018, February). *Student Understanding of Linear Combinations of Eigenvectors*. Paper presented at the 21<sup>st</sup> Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Wawro, M., Watson, K., & Christensen, W. (2018, February). *Quantum Physics Students' Reasoning about Eigenvectors and Eigenvalues*. Poster presented at the 21<sup>st</sup> Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Musgrave, S., Hagman, J.E., Melhuish, K., Thanheiser, E., & Wawro, M. (2018, February). *MPWR-ing Women in RUME: Continuing Support*. Poster presented at the 21<sup>st</sup> Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Robinson, A., Simonetti, J. H., Richardson, K. L., Esmaili, S., Grimes, M., Lewis, S. N., McConnell, K. D., Pleimling, M., Sible, J. C., Sorenson, K., Vengrin, C., & Wawro, M. (2018, January). *A study of learning and attitudinal gains in a first-year physics experience*. Poster presented at the 2018 meeting of the American Association of Physics Teachers, San Diego, CA.
- Wawro, M., Zandieh, M., & Plaxco, D. (2017, November). *An Inquiry-Oriented Approach to the Guided Reinvention of Eigentheory*. Paper presented at the 11th Southern Hemisphere Conference on the Teaching and Learning of Undergraduate Mathematics and Statistics (DELTA), Gramado, Brazil.
- Wawro, M., Watson, K., & Christensen, W. (2017, July). *Investigating Students' Meta-Representational Competence with Matrix Notation and Dirac Notation*. Paper presented at the Physics Education Research Conference, Cincinnati, OH.
- Wawro, M. (2017, July). *Inquiry-Oriented Linear Algebra (IOLA): An Overview and an Example*. Presentation given at the Meeting of the International Linear Algebra Society, Ames, IA.



- Wawro, M., Watson, K., & Christensen, W. (2017, February). *Meta-representational competence with linear algebra in quantum mechanics*. Paper presented at the 20th Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Watson, K., Wawro, M., Zandieh, M., & Kerrigan, S. (2017, February). *Knowledge about student understanding of eigentheory: Information gained from multiple choice extended assessment*. Paper presented at the 20th Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Ellis, J., Musgrave, S., Melhuish, K., Thanheiser, E., & Wawro, M. (2017, February). *Empowered women in RUME: We have we been up to?* Poster presented at the 20th Conference on Research in Undergraduate Mathematics Education, San Diego, CA.
- Wawro, M., Watson, K., & Christensen, W. (2017, February). *Meta-representational competence with linear algebra in quantum mechanics*. Paper presented at the 10<sup>th</sup> Congress of European Research in Mathematics Education, Dublin, Ireland.
- Borum, V., Lovin, L., Wawro, M., & White, N. (2017, January). *Highlighting contributions to mathematics education from members of departments of mathematics sciences*. Panel discussion sponsored by the MAA COMET and the AWM presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society, Atlanta, GA.
- Ellis, J., Musgrave, S., Wawro, M., Thanheiser, E., & Melhuish, K. (2017, January). *MPWR 2016 and Beyond: Fostering sustainable networks for women in RUME*. Poster presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society, Atlanta, GA.
- Wawro, M., & Watson, K. (2017, January). *An interdisciplinary study of learning: Student understanding of linear algebra in physics*. Poster presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society, Atlanta, GA.
- Wawro, M., & Zandieh, M., & Rasmussen, C. (2016, July). *Symbolizing and brokering in fostering inquiry*. Paper presented at the 13<sup>th</sup> International Congress on Mathematical Education, Hamburg, Germany.
- Rasmussen, C., & Wawro, M. (2016, August). *Coordinating analyses of individual and collective mathematical progress*. Paper presented in the “Mathematics Learning and Teaching at University Level” Research Forum at the Psychology of Mathematics Education 40<sup>th</sup> Annual Conference, Szeged, Hungary.
- Wawro, M., & Zandieh, M. (2016, April). *An inquiry-oriented task sequence for eigentheory and diagonalization in linear algebra*. Poster presented at the First Conference of the International Network for Didactic Research in University Mathematics (INDRUM), Montpellier, France.
- Zandieh, M., Wawro, M., & Rasmussen, C. (2016, February). *Symbolizing and brokering in an inquiry-oriented linear algebra classroom*. Paper presented at the Nineteenth Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.
- Watson, K., Wawro, M., & Zandieh, M. (2016, February). *Assessing students' understanding of eigenvectors and eigenvalues in linear algebra*. Poster presented at the Nineteenth Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.
- Wawro, M., Ellis, J., & Soto-Johnson, H. (2015, April). *Lessons learned from mentioning and partnerships for women in research in undergraduate mathematics education*. Poster presented at the American Educational Research Association (AERA) Annual Meeting, Chicago, IL.
- Wawro, M., Zandieh, M., Rasmussen, C., & Andrews-Larson, C. (2015, February). *An RME-based instructional sequence for change of basis and eigentheory*. Poster presented at the 18<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.
- Christensen, W., & Wawro, M. (2015, February). *Education research at the interface of mathematics and physics*. Working group organized at the 18<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.

- Rasmussen, C., Wawro, M., & Zandieh, M. (2015, February). *Examining individual and collective level mathematical progress*. Paper presented at the 18<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.
- Zandieh, M., Plaxco, D., Wawro, M., Rasmussen, C., Milbourne, H., & Czeranko, K. (2015, February). *Extending multiple choice format to document student thinking*. Paper presented at the 18th Conference on Research in Undergraduate Mathematics Education, Pittsburgh, PA.
- Wawro, M., & Plaxco, D. (2015, February). *Student understanding of linear independence of functions*. Poster presented at the 9<sup>th</sup> Congress of European Research on Mathematics Education, Prague, Czech Republic.
- Wawro, M., Zandieh, M., & Plaxco, D. (2015, January). *An instructional sequence for change of basis and eigentheory*. Paper presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society [MAA Session on Innovative and Effective Teaching of Linear Algebra], San Antonio, TX.
- Zandieh, M., Wawro, M., & Plaxco, D. (2015, January). *Inquiry-Oriented Linear Algebra (IOLA): An RME-based instructional sequence for change of basis and eigentheory*. Paper presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society [SIGMAA on RUME Session on Research on the Teaching and Learning of Undergraduate Mathematics], San Antonio, TX.
- Wawro, M., Zandieh, M., Rasmussen, C., Larson, C., Plaxco, D., & Czeranko, K. (2014, February). *Developing inquiry oriented instructional materials for linear algebra (DIOIMLA): Overview of the research project*. Poster presented at the Seventeenth Conference on Research in Undergraduate Mathematics Education, Denver, CO.
- Plaxco, D., Wawro, M., & Zietsman, L. (2014, February). *Student understanding of linear independence of functions*. Paper presented at the Seventeenth Conference on Research in Undergraduate Mathematics Education, Denver, CO.
- Larson, C., Wawro, M., Zandieh, M., Rasmussen, C., Plaxco, D., & Czeranko, K. (2014, February). *Implementing inquiry-oriented instructional materials in undergraduate mathematics*. Paper presented at the Seventeenth Conference on Research in Undergraduate Mathematics Education, Denver, CO.
- Plaxco, D., & Wawro, M. (2013, November). *Characterizing student conceptions of span and linear independence through mathematical activity: The case of Joe*. Poster presented at the Thirty-fifth Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Chicago, IL.
- Wawro, M. (2013, June). *Designing instruction that builds on students' ways of reasoning in linear algebra: an example from span and linear independence*. Paper presented at the 2013 Meeting of the International Linear Algebra Society, Providence, RI.
- Wawro, M., & Christensen, W. (2013, February). *Investigating student understanding of cross-cutting concepts within undergraduate mathematics and physics*. Working group organized at the 16<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Denver, CO.
- Wawro, M., & Plaxco, D. (2013, February). *Utilizing types of mathematical activities to facilitate characterizing student understanding of span and linear independence*. Paper presented at the 16<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Denver, CO.
- Wawro, M. (2013a, January). *Reasoning about solutions in linear algebra: The case of Abraham and the Invertible Matrix Theorem*. Paper presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society [SIGMAA on RUME Session on Research on the Teaching and Learning of Undergraduate Mathematics], Boston, MA.

- Wawro, M. (2013b, January). *Transitioning from graduate student to faculty member: Learning to lead a research project team*. Poster presented at the Project STaR Session at the 17<sup>th</sup> Annual Association of Mathematics Teacher Educators Conference, Orlando, FL.
- Wawro, M. (2012, November). *Student reasoning about the Invertible Matrix Theorem in linear algebra*. Poster presented at the Thirty-fourth Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Kalamazoo, MI.
- Wawro, M. (2012, July). *Student thinking about the Invertible Matrix Theorem in linear algebra*. Paper presented at the 12th International Congress on Mathematics Education [roundtable discussion within the Learning and Cognition in Mathematics Topic Study Group], Seoul, South Korea.
- Rasmussen, C., & Wawro, M. (2012, July). *Documenting the collective activity of the mathematics classroom*. Paper presented at the 12th International Congress on Mathematics Education [Learning and Cognition in Mathematics Topic Study Group], Seoul, South Korea.
- Wawro, M. (2012, June). *Reasoning about existence and uniqueness of solutions to  $Ax=0$  and  $Ax=b$  in linear algebra: Abraham and the IMT*. Poster presented at the Second Conference on Transforming Research on Undergraduate STEM Education, St. Paul, MN.
- Rasmussen, C., Wawro, M., & Zandieh, M. (2012, April). *Four lenses for examining individual and collective level mathematical progress*. Paper presented at the American Educational Research Association (AERA) Annual Meeting [symposium on Connecting the Moving Dots: Comparing Approaches to Coordinating Temporal Analyses of Groups and Individuals], Vancouver, BC.
- Wawro, M. (2012, February). *Expanding Toulmin's Model: The development of four expanded argumentation schemes from analysis in linear algebra*. Paper presented at the Fifteenth Conference on Research in Undergraduate Mathematics Education, Portland, OR.
- Wawro, M., Larson, C., Zandieh, M., & Rasmussen, C. (2012, February). *A hypothetical learning trajectory for conceptualizing matrices as linear transformations*. Paper presented at the Fifteenth Conference on Research in Undergraduate Mathematics Education, Portland, OR.
- Wawro, M., & Larson, C. (2012, January). *A hypothetical learning trajectory for conceptualizing matrices as linear transformations*. Paper presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society [MAA Session on Innovative and Effective Teaching of Linear Algebra], Boston, MA.
- Wawro, M. (2011, February). *Individual and collective analysis of the genesis of student reasoning regarding the Invertible Matrix Theorem in linear algebra*. Paper presented at the 14<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Portland, OR.
- Wawro, M., Zandieh, M., Sweeney, G., Larson, C., & Rasmussen, C. (2011, February). *Using the emergent model heuristic to describe the evolution of student reasoning regarding span and linear independence*. Paper presented at the 14<sup>th</sup> Conference on Research in Undergraduate Mathematics Education, Portland, OR.
- Sweeney, G., & Wawro, M. (2011, January). *Revoicing as a tool for promoting effective student discourse*. Roundtable paper presented at the Fifteenth Annual Association of Mathematics Teacher Educators Conference, Irvine, CA.
- Wawro, M. (2011a, January). *A student-centered approach to span and linear independence: The case of the magic carpet ride problem*. Paper presented at the Joint Mathematics Meetings of the Mathematical Association of America and the American Mathematical Society [MAA Session on Innovative and Effective Teaching of Linear Algebra], New Orleans, LA.
- Wawro, M. (2011b, January). *Development of student reasoning regarding the Invertible Matrix Theorem in linear algebra*. Paper presented at Joint Mathematics Meetings of the Mathematical Association of

America and the American Mathematical Society [SIGMAA on RUME Session on Research on the Teaching and Learning of Undergraduate Mathematics], New Orleans, LA.

Wawro, M. (2010, October). *Individual and collective analyses of the genesis of student reasoning regarding the Invertible Matrix Theorem*. Poster presented at the Thirty-second Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Columbus, OH.

Rasmussen, C., Zandieh, M., & Wawro, M. (2010, October). *Brokering as a mechanism for the social production of meaning*. Brief research report presented at the Thirty-second Annual Conference of the North American Chapter of the International Group for the Psychology of Mathematics Education (PME-NA), Columbus, OH.

Rasmussen, C., Zandieh, M., & Wawro, M. (2010, June). *Brokering as a mechanism for the social production of meaning*. Symposium on social construction of mathematical meaning through collaboration and argumentation. Paper presented at the Ninth International Conference of the Learning Sciences, Chicago, IL.

Cole, R., Towns, M., Rasmussen, C., Becker, N., Wawro, M., & Sweeney, G. (2010, February). *Adapting a methodology for documenting collective growth to an undergraduate physical chemistry class*. Paper presented at the Thirteenth Conference on Research in Undergraduate Mathematics Education, Raleigh, NC.

Henderson, F., Rasmussen, C., Sweeney, G., Wawro, M., & Zandieh, M. (2010, February). *Symbol sense in linear algebra*. Paper presented at the Thirteenth Conference on Research in Undergraduate Mathematics Education, Raleigh, NC.

Wawro, M., Sweeney, G., & Rabin, J. M. (2010, February). *Subspace in linear algebra: Investigating students' concept images and interactions with the formal definition*. Paper presented at the Thirteenth Conference on Research in Undergraduate Mathematics Education, Raleigh, NC.

Wawro, M. (2009, February). *Task design: Towards promoting a geometric conceptualization of linear transformation and change of basis*. Paper presented at the Twelfth Conference on Research in Undergraduate Mathematics Education, Raleigh, NC.

Rasmussen, C., Zandieh, M., & Wawro, M. (2009, February). *The social production of meaning*. Paper presented at the Twelfth Conference on Research in Undergraduate Mathematics Education, Raleigh, NC.

## GRADUATE STUDENT SUPERVISION

- George Kuster (advisor), PhD, Virginia Tech, 2016  
Dissertation Title: *On the Role of Student Understanding of Function and Rate of Change in Learning Differential Equations*  
Current position: Assistant Professor, Christopher Newport University
- David Plaxco (advisor), PhD, Virginia Tech, 2015  
Dissertation Title: *Relating Understanding of Inverse and Identity to Engagement in Proof in Abstract Algebra*  
Current position: Assistant Professor, Clayton State University
- Rachel Rupnow (committee member), PhD, Virginia Tech, 2019
- Steven Boyce (committee member), PhD, Virginia Tech, 2014
- Master's and PhD advisor for Kevin Watson
- Doctoral committee member for Cong ze Xu, Ahsan Chowdhury, and Kaitlyn Serbin
- Master's presentation advisor for Neal Aronson

## REVIEWER FOR PROFESSIONAL JOURNALS

- Journal for Research in Mathematics Education

- Educational Studies in Mathematics
- International Journal of Research in Undergraduate Mathematics Education
- Cognition and Instruction
- Journal of Mathematical Behavior
- Mathematics Education Research Journal
- Canadian Journal for Science, Mathematics, and Technology Education
- Problems, Resources, and Issues in Mathematics Undergraduate Studies (PRIMUS)

### **REVIEWER FOR PROFESSIONAL CONFERENCES**

- Special Interest Group of the Mathematical Association of America on Research in Undergraduate Mathematics Education (RUME)
- Congress for European Research in Mathematics Education (CERME)
- Joint Mathematics Meetings and MathFest
- International Network for Didactic Research in University Mathematics (INDRUM)
- International Group for the Psychology of Mathematics Education, North American Chapter Annual Conference (PME-NA)

### **MEMBERSHIPS IN PROFESSIONAL SOCIETIES**

- Mathematical Association of America (MAA) and Special Interest Group of the MAA on Research in Undergraduate Mathematics Education (SIGMAA on RUME)
- Association for Women in Mathematics (AWM)
- European Society for Research in Mathematics Education (ERME)
- International Linear Algebra Society (ILAS)
- International Group for the Psychology of Mathematics Education (PME)
- Virginia Council of Teachers of Mathematics (VCTM)

### **SERVICE TO THE RESEARCH COMMUNITY**

- Editorial Board member for the International Journal for Research in Undergraduate Mathematics Education, 2016-present
- Elected member of the Executive Committee (Program Chair), SIGMAA on RUME, 2016-2020
- Member of the Planning Committee for the Annual Conference on Research in Undergraduate Mathematics Education, 2012-present
- Lead developer for the NSF-funded (DUE-1245673, 1245796, and 1246083) Inquiry-Oriented Linear Algebra (IOLA) curriculum materials. Materials maintained and available to interested university instructors at <http://iola.math.vt.edu>
- Consultant for the research project, National Science Foundation Innovations in Undergraduate STEM Education, Simulation-Based Inquiry-Oriented Linear Algebra (#1712524); M. Zandieh (PI), A. Amresh, D. Plaxco (co-PIs), \$299,999, 2017-20.
- Curriculum Advisory Board member for the research project, National Science Foundation Innovations in Undergraduate STEM Education, Collaborative Research: Teaching Inquiry-Oriented Mathematics: Establishing Supports (#143195, 1431641, 1431393), E. Johnson (PI); K. Keene, C. Andrews-Larson (co-PIs), \$999,773, 2014-17
- Executive Committee member for the research project, National Science Foundation, Transforming Research in Undergraduate STEM Education (DUE #151038); W. Christensen (PI), C. Rasmussen, J. Thompson, M. Towns, (co-PIs), \$49,994, 2015.
- Co-organizer (with Rachel Quinlan, National University of Ireland, Galway) of the Mathematics Education mini-symposium at the 2017 Annual Meeting of the International Linear Algebra Society

- Co-organizer (with David Strong, Pepperdine University, and Gil Strang, MIT) of the MAA Session on Innovative and Effective Ways to Teach Linear Algebra, Joint Mathematics Meetings, 2014-present
- Co-organizer (with Warren Christensen, North Dakota State University) of the Math-Physics Working Group, Annual Conference on Research in Undergraduate Mathematics Education (RUME), 2013, 2015
- Panel reviewer for EHR Directorate at the National Science Foundation, 2015, 2016, 2017
- Reviewer for the Israeli National Science Foundation
- Graduate Student Panelist for the Southern California Undergraduate Mathematics Conference, organized by University of California San Diego's chapter of the Association for Women in Mathematics (AWM), 2010
- Local organizing committee member for the Fifth Biennial National Conference of Cognitively Guided Instruction (CGI), San Diego, CA, 2009
- Local organizing committee member for the Eleventh Annual Conference of the Special Interest Group of the Mathematical Association of America on Research in Undergraduate Mathematics Education, San Diego, CA, 2008

### **COURSES TAUGHT AT VIRGINIA TECH**

- MATH 1114H Elementary Linear Algebra for Honors
- MATH 2114 Introduction to Linear Algebra
- MATH 3144 Linear Algebra I
- MATH 4625 Mathematics for Secondary Teachers
- MATH 4626 Mathematics for Secondary Teachers
- MATH 4664 Senior Mathematics Education Seminar
- MATH 5634 Research in Undergraduate Mathematics Education

### **SERVICE TO THE UNIVERSITY**

- Mathematics Department Undergraduate Program Committee, 2013-2016, 2017-2018
- Mathematics Education Program Committee, 2011-present
- Mathematics Travel Fund Committee, 2018-present
- Mathematics Department Scholarship Committee, 2012-2014
- MATH 2114 Course Co-Coordinator, 2014
- Mathematics Department tenure-track Mathematics Education search committee member, 2012-2013
- Mathematics Department Patricia A. Caldwell Postdoctoral Researcher search committee member, 2016-2017
- College of Science tenure-track Integrated Science search committee member, 2012-2013
- Panelist in the New Faculty Mentoring Program, sponsored by the Office of the Provost, 2012 & 2014
- Led the development of the course, *MATH 5634 Research in Undergraduate Mathematics Education*, first offered Spring 2012 and made permanent in 2013
- Worked with department colleagues to develop *MATH 2114 Introduction to Linear Algebra*, first offered and made permanent in Fall 2014. Served as course co-coordinator, 2014-15