I'm not a robot

The CLSE is committed to using evidence-based practices in all of our courses. As part our mission, we pursue programmatic, curricular, and pedagogical innovations in biology teaching, we measure the impact of these changes on student learning, and we disseminate information about our best practices among faculty, staff, graduate students, and undergraduate students in the college, as well as to the larger community. We are actively conducting research designed to better understand how our programs and pedagogical innovations in biology teaching help students learn biology, increase their motivation to learn biology, and be retained in STEM fields. Below is a list recent publications and presentations.Peer-Reviewed Journal ArticlesWright, A. M., Tacloban, M.J., Lake, S. et al. Towards a comprehensive understanding of science practices: a heuristic for increasing educator familiarity across a series of science education frameworks. Discover Education 3, 235 (2024). A.M., McCarney, M. The Adoption of a Questionnaire to Evaluate High School Science Teachers Motivation for Reading and Teaching with Primary Scientific Literature. Journal of Science Teacher Education (2024). E.E., & Kulesza, A.E. (In Press). Classroom community measures increase with a Graduate TA, in-person delivery, and upper-level number in undergraduate biology lab courses.Journal of College Science Teaching.Kulesza, A.E., DAgostino, S., & L.B. Chacn-Diaz. (2024). Investigating Effects of Emergency Remote Teaching on Biology Teaching Assistants and their Approaches to Teaching. Journal of College Science Teaching, 1-7. N.L., Kulesza, A.E. Inquiry-Team-Based Lab Course Design Enhances Underrepresented Undergraduate Predictors of Persistence in the Sciences. Med.Sci.Educ. (2024). A.E, & Gallant, D.J. (2023). Initial Development and Validation of the Biology Teaching Assistant Role Identity Questionnaire (BTARIQ). Journal of College Science Teaching, 52(5), 80-90.Kulesza, A.E., Imtiaz, S., & Bernot, K.M. (2022). Building Connections to Biology and Community through Service-Learning and Research Experiences. JMBE, A. C., Hensley, L. C., Sovic, D., Kulesza, A., Wolters, C. A., & Breitenberger, C. (2022). What makes a study strategy intervention impactful? An interview-based study. College Student Affairs Journal, 40(1), 17-31.Miller, K.R., Ridgway, J.S., Marbach-Ad, G., Schussler, E.E., & Gardner GE. (2022). The BioTAP Professional Development model: Expanding empirical research on graduate student teaching professional development. CourseSource. L., Kulesza, A., Peri, J., Brady, A. C., Wolters, C. A., Sovic, D., & Breitenberger, C. (2021). Supporting Undergraduate Biology Students Academic Success: Comparing Two Workshop Interventions. CBE-Life Sciences Education, 20(4), DOI: 10.1187/cbe.21-03-0068Newman-Griffis, A. H., Sypolt, E., Sagatelova, M., Cubonova, L., Danhart E., Kulesza, A.E. (2020). Data Analysis Recitation Activities Support Better Understanding in SEA-PHAGES CURE. CourseSource. D.M., & Chordas, S.W. III. (2020). Tying it all together: An activity to help students connect course experiences to posted learning outcomes.CourseSource. E.C., & Ridgway, J.S. (2019). Development of an enhanced peer mentoring program: Partnering with novice teaching assistants in a teaching community of practice. Journal on Excellence in College Teaching, 30(1), 51-75.Calhoon, E.A., Pieterson, E.C., & Gougherty, S. (2019). Plant Growth and Climate Change: Urban Trees Role as a Carbon Sink. Tested Studies in Laboratory Teaching, 40, 2019, Volume 40.Herrmann, S. & Ligocki, I. (2019). Wetlands Ecology and Human Impacts Lab: Connecting Students with Their Local Environment. Tested Studies in Laboratory Teaching, 40, 2019, Volume 40.Bernot, K.M., Kulesza, A.E., & Ridgway, J.S. (2017). Service learning as inquiry in an undergraduate science course. The American Biology Teacher, 79(5), 393-400.Ridgway, J.S., Ligocki, I.Y., Horn, J.D., Szeyller, E., & Breitenberger, C.A. (2017). Teaching assistant and faculty perceptions of ongoing, personalized TA professional development: Initial lessons and plans for the future. Journal of College Science Teaching, 46(5), 73.Reeves, T.D., Marbach-Ad, G., Miller, K.R., Ridgway, J.S., Gardner, G.E., Schussler, E.E., & Wischusen, E.W. (2016). A conceptual framework for graduate teaching assistant professional development evaluation and research. CBE-Life Sciences Education, 15(2), pii:es2Holding, M.L., Denton, R.D., Kulesza, A.E., & Ridgway, J.S. (2014).Confronting scientific misconceptions by fostering a classroom of scientists in the introductory biology lab. The American Biology Teacher, 76(8), 518-523.Kulesza, A.E., Clawson, M.E., & Ridgway, J. S. (2014). Student success indicators associated with clicker-administered quizzes in an honors introductory biology course. Journal of College Science Teaching,43(4), 73-79.Book ChaptersGardner, G., Ridgway, J., Schussler, E., Miller, K., & Marbach-Ad, G. (2020). Research Coordination Networks to Promote Cross-Institutional Change: A Case Study of Graduate Student Teaching Professional Development.Transforming Institutions: Accelerating Systemic Change in Higher Education.Conference Presentations: TalksRoberts, T., Kulesza, A.E. (2023, October) Developing a Comprehensive Codebook for Analyzing Transcribed Interview Data on the Impact of Professional Development on Teaching Assistants and their Students: A Pilot Study.Presentation at the 2023BioTap (Biology Teaching Assistant Project) Virtual Conference.Herrmann, S. & Szeyller, E. (2023, June).eBird Community Science Project: Engaging Non-Major Biology Students in Authentic and Meaningful Research. Major Workshop presented at the 44thAnnual Association for Biology Laboratory Education (ABLE) Conference. San Diego, CA.Sovic, D. M. (2019, November) A Collaborative, Structured, Data-Driven Effort to Guide Instructional Redesign. Interactive Session presented at the 44thAnnual POD Network Conference, Pittsburgh, PA.Kulesza, A.E., Bernot, K.M., & Ridgway, J.S. (2019, July). Comparison of service-learning and research projects in an introductory biology class. Presentation at the Society for the Advancement of Biology Education Research (SABER) annual meeting, Minneapolis, MN.Kern, A., Esparza, D., Kulesza, A., Pieterson, C., Rivera, S., & Olimpo, J.T. (2019, June). Developing, Implementing, and Evaluating Professional Development Initiatives for Graduate Teaching Assistants Facilitating Course-based Undergraduate Research Experiences (CUREs). Mini Workshop presented at the 41st Annual Association for Biology Laboratory Education (ABLE) meeting, Ottawa, ON.Sovic, D. M. (2019, May). Ideas and instruments for course redesign: Part II A new tool for course characterization. Presentation at the 13th Annual Conference on Excellence in Teaching and Learning, Columbus, OH.Kulesza, A.E., DAgostino, J.V., & Ridgway, J.S. (2019, April). An evaluation of the differential effects of the prerequisite pathways on student performance in an introductory biology course. Presentation at the Accelerating Systematic Change Network (ASCN) meeting, Pittsburg, PA.Schussler, E.E., Gardner, G., Marbach-Ad, G., Miller, K., & Ridgway, J. (2019, April). The biology teaching assistant project: Theory of change for a network. Presentation at the Accelerating Systematic Change Network (ASCN) meeting, Pittsburgh, PA.Calhoon, E.A., Pieterson, E.C., & Gougherty, S. (2018, July). Plant Growth and Climate Change: Urban Trees Role as a Carbon Sink. Interactive Major Workshop presented at the 40th Annual Conference of the Association for Biology Laboratory Education (ABLE), Columbus, OH.Horn, J.D., & Szeyller, E. (2018, June). Creating collaborative, TA-centered weekly instructional meetings to support student-centered laboratory instruction. Extended Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Kulesza, A.E., & Pearson, S.A. (2018, June). Training teaching assistants as active participants in large, active learning, lectures. Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Miller, K., Ridgway, J.S., Coker, R., Price, K.E., Stewart, K., Gardner, G., Marbach-Ad, G., & Schussler, E. (2018, June). BioTAP 2.0 (Biology Teaching Assistant Project): Engaging individuals in scholarly research about biology. Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Herrmann, S. & Ligocki, I. (2018, June). Wetlands Ecology and Human Impacts Lab: Connecting Students with Their Local Environment. Interactive Major Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Conerly, C. & Nguyen, E. (2018, June). Understanding Marine and Aquatic Ecology in Biology Labs in a Microcosm: An Alternative Integration to the Curriculum. Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Chordas, S. & Breitenberger, C. (2018, June). The DNA Damage Game. Extended Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Szeyller, E., & Ridgway, J.S. (2018, June). Six lessons from administering a biology teaching professional development course. Mini Workshop presented at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Guannel, M., Kulesza, A.E., & Midden, W.R. (2018, June). Impacts of service learning on student engagement with science; examples from introductory courses at three higher education institutions. Presentation at the Network of STEM Education Centers (NSEC) annual meeting, Columbus, OH.Marbach-Ad, G., Gardner, G., Miller, K., Ridgway, J., & Schussler, E. (2018, March). Network initiative to develop research skills in professional developers working with biology teaching assistants. Presentation at the 91th National Association for Research in Science Teaching (NARST) annual meeting, Atlanta, GA.Miller,K., Gardner, G., Marbach-Ad, G., Ridgway, J., Schussler, E., Fuselier, L., Trimby,C., Pavlova, I.,Szeyller, E.,Marion, A., Oran, A., Shortlidge, E.,Chouinard, A., Floyd, J., Serreyn, M., Abney,N., Lee, S., Nelson, K., Olimpo, J., Raut, S., & Vance-Chalcraft, H. (2017, June).BioTAP2.0 (Biology Teaching Assistant Project): Engaging individuals in scholarlyresearch about biology. Mini Workshoppresented at the 39thAnnualAssociation for Biology Laboratory Education (ABLE) meeting, Madison, WI.Reid, J., Chen, M., Carroll, P.A., Gardner, G., Marbach-Ad, G., Miller, K.R., Ridgway, J., & Schussler, E. (2017, November). A critical review of the literature on biology graduate teaching assistant professional development. Presentation at the National Association of Biology Teachers (NABT) National Meeting, St. Louis, MO.Sovic, D.M. (2017, November). Identifying best practices in the use of learning outcomes: Transforming administrative artifacts into tools for metacognitive practice. Presentation at the 37th Annual Original Lilly Conference on College Teaching, Oxford, OH.Breitenberger,C. A., Ridgway, J. S.,Szeyller, E.,Sovic, D., & Kulesza, A. E. (2017, May) Multiple professional development on-ramps intoteaching communities of practice. Presentation at the 11thAnnual Ohio State University Conference on Excellence in Teaching & Learning, Columbus,OH.Gardner, G., Schussler, E., Marbach-Ad, G., Miller, K., & Ridgway, J. (2017, February). The biology teaching assistant project 2.0: Advancing research, synthesizing evidence. Presentation at the annual meeting of the Tennessee STEM Education Research Conference hosted by Tennessee STEM Education Center (TSEC), Murfreesboro, TN.Kulesza, A.E., Ridgway, J.S., Shawver, B., Gordon, A. & Bernot, K.M. (2017, January). Community engagement through a health-related honors biology service-learning project. Presentation at the Community Engagement Conference, The Ohio State University, Columbus, OH.Kulesza, A.E., Bernot, K.M., Ridgway, J.S., & Pieterson, E.C. (2014, July). Comparison of service learning and research projects in an introductory biology class. Presentation at the Society for the Advancement of Biology Education Research (SABER) annual meeting, Minneapolis, MN.Kulesza, A.E., Clawson, M.E., & Ridgway, J.S. (2012, November). Investigation of student learning gains associated with clicker use in an introductory biology course. Presentation at the Lilly International Conference on College Teaching, Miami University, Oxford, OH.Conference Presentations: PostersKulesza, A.E., DAgostino, S., & L.B. Chacn-Diaz. (2023). Investigating Effects of Emergency Remote Teaching on Biology Teaching Assistants and their Approaches to Teaching.SABER, Minneapolis, MN.Szeyller, E., & Ridgway, J.S. (2022, November) Connecting STEM Instructors with Appropriate Student-centered Teaching Professional Development. Poster Presentation at the 47thAnnual POD Network Conference, Seattle, WA.Szeyller, E., Ridgway, J.S., & Breitenberger, C.A. (2019, November). Creating Links: Promoting Motivation and Community in Online Instruction. Poster Presentation at the 44thAnnual POD Network Conference, Pittsburgh, PA.Kulesza, A.E., DAgostino, J.V., & Ridgway, J.S. (2019, June). Exploration of the differential effects of prerequisite pathways on student performance in an introductory biology course using predictive models. Poster Presentation at the Gordon Research Conference Undergraduate Biology Education meeting, Lewiston, ME.Kulesza, A.E., DAgostino, J.V., & Ridgway, J.S. (2019, June). The use of hierarchical linear modeling to evaluate the differential effects of prerequisite pathways on student performance in an introductory biology course. Poster Presentation at the Gordon Research Seminar Undergraduate Biology Education Research meeting, Lewiston, ME.Sovic, D.M. (2018, October). Course learning outcomes: Administrative artifacts or tools for student success? Poster Presentation at the Franklin Scholars Showcase: Innovations in Leadership and Learning, Columbus, OH.Gardner G., Schussler, E., Miller, K., Marbach-Ad, G., Ridgway, J., Reid, J., & Chen, M. (2018, July). Current literature on biology graduate teaching assistant teaching professional development (GTA TPD): Mapping a research agenda. Poster Presentation at the Society for the Advancement of Biology Education Research (SABER) annual meeting, Minneapolis, MN.Kulesza, A.E., Bernot, K.M., & Breitenberger, C.A. (2018, July). Evaluating the impact of service learning by exploring student long term memory and emotion. Poster Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Pieterson, E.C., Bolen, D.S., Calhoon, E.A., McCarthy, R.L., Miriti, M., & Curtis, P.S. (2018, June). Collaborative (Re)design of Ecology Lab Exercises. Poster presentation at the 40th Annual Association for Biology Laboratory Education (ABLE) meeting, Columbus, OH.Marbach-Ad, G., Ridgway, J., Gardner,G., Miller, K., & Schussler,E. (2018, June). Biology Teaching Assistant Project (BioTAP 2.0): A Network to Build a Capacity for Collaborative Research on Biology Graduate Teaching Assistant Teaching Professional Development (GTA TPD). Poster Presentation at the Network of STEM Education Centers annual meeting (NSEC), Columbus, OH.Kulesza, A.E., Bernot, K.M., & Breitenberger, C.A. (2017, July). Memory, motivation, and making connections: Long-term outcomes associated with service-learning and research experiences. Poster Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Schussler, E., Gardner, G., Marbach-Ad, G., Miller, K., & Ridgway, J. (2017, July). Networking for change: Assessing the capacity for research on graduate student teaching professional development. Poster Presentation at the Society for the Advancement of Biology Education Research (SABER) annual meeting, Minneapolis, MN.Marbach-Ad, G., Schussler, E., Gardner, G., Miller, K., & Ridgway, J. (2017, November). A network for research on biology graduate teaching assistant teaching professional development. Poster Presentation at the AAC&U Transforming STEM Higher Education Conference, San Francisco, CA.Kulesza, A.E., Bernot, K., Ridgway, J.S., & Pieterson, E.C. (2015, July). Comparison of service-learning and research projects in an honors introductory biology class. Poster Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Ridgway, J.S., Kulesza, A.E., & Breitenberger, C.A. (2015, July). Changes in student motivation and scientific literacy associated with participation in course-based undergraduate research experiences. Poster Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Bernot, K.M., Kulesza, A.E., & Ridgway, J.S. (2013, November). Use of service learning to integrate real world application in an honors introductory biology course. Poster Presentation at the Lilly International Conference on College Teaching, Miami University, Oxford, OH.Conference Presentations: RoundtablesKern, A., Esparza, D., Kulesza, A.E., Pieterson, C., Rivera, S., & Olimpo, J.T. (2019, July). Designing professional development initiatives for graduate teaching assistants facilitating course-based undergraduate research experiences (CUREs). Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Sovic, D.M. (2018, June). Learning outcomesAdministrative artifacts or tools for instructor and student metacognitive practice? Roundtable Presentation at the Network of STEM Educators (NSEC) annual meeting, Columbus, OH.Ridgway, J.S., Wheeler, L., Szeyller, E., Horn, J.D., & Pieterson, E.C. (2018, June). STEM teaching assistants: Two models for supporting TAs in learning, valuing, and implementing evidence-based instructional practices. Roundtable Presentation at the Network of STEM Educators (NSEC) annual meeting, Columbus, OH.Ridgway, J.S., Breitenberger, C.A., Kulesza, A.E., & Sovic, D.M. (2018, June). Faculty professional development offered four ways. Roundtable Presentation at the Network of STEM Education Centers (NSEC) annual meeting, Columbus, OH.Kulesza, A.E., Bernot, K.M., & Ridgway, J.S. (2016, July). Long-term outcomes associated with high impact practices in an honors biology course. Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Faust, S., Ridgway, J.S., Kulesza, A.E., & Breitenberger, C.A. (2015, July). Changes in introductory biology student content knowledge and motivation associated with participation in peer-led team learning. Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Pieterson, E.C., & Ridgway, J.S. (2015, July). Changes in teaching anxiety, attitudes, and behaviors associated with a TA peer mentoring program. Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Schussler, E., Ridgway, J.S., Gardner, G., Miller, K., & Marbach-Ad, G. (2015, July). Networking to promote the assessment of GTA professional development. Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN.Szeyller, E., Ridgway, J.S., & Breitenberger, C.A. (2015, July). Online vs. race-to-face human biology instruction: Does format matter for student experience? Roundtable Presentation at the Society for the Advancement of Biology Education (SABER) annual meeting, Minneapolis, MN. The focus of this concentration is research on learning and instruction specific to the discipline of biology at the undergraduate and graduate levels. Researchers in this group study how students learn biological concepts and practices, the development of disciplinary identities and values, the influence of curriculum and instruction on learning, and the intersection between biology learning and issues of equity and social justice. Research in this concentration involves collaboration between education researchers and faculty in the Biology Department. Sites of study include biology lecture or lab courses or sites of biology learning outside of classroom contexts.Faculty MentorsJulia SvobodaMitch McVeyEric TytellLawrence UricchioBen Wolfe Our general philosophy regarding coursework is that you take only classes that you need to pick up skills that are important to your research. The basic requirements for the first two years of the Ph.D. program are described below. Optional coursework will include courses in Biology and in Education as relevant and appropriate. Examples of optional courses are listed below, but ultimately, the decision about what additional elective classes to take will be up to you and your committee.RequiredYear 1Two research Rotations (PhD students only, 1 rotation per semester); research rotations are registered as courses (Bio 253, Bio 254) they are generally done with faculty in the Biology Department, but mentors outside the department can also be enlisted.First year that you are a teaching assistant: All students that are Teaching Assistants are required to take Pedagogy (Bio 260)Year 1 or 2Two advanced graduate-level seminars in Biology (100 or 200-level)STEM Education Program Seminar (ED 222/223)Two electives in Education Developmental Biology (Bio 103)Molecular Biology (Bio 105)Endocrinology (Bio 110)Physiology of Movement (Bio 117)Animal Behavior (Bio 130)Biostatistics (Bio132)Ecology of Animal Movement (Bio 135)Population and Community Ecology (Bio 142)Evolutionary Biology w/lab (Bio 143)Principles of Conservation Biology (Bio 144)Computational Laboratory in Population Genomics (Bio 145)Darwinian Medicine Seminar (Bio 183)Food for All: Ecology, Biotechnology and Sustainability (Bio 185)Seminar in Molecular Evolution (Bio 196)Development Of Knowledge And Reasoning In The Science Curriculum (ED 111)Human Development And Learning (ED 130)Anthropology and Sociology of Schooling (ED 161)Philosophies (ED 163)Critical Race Theory (ED 167)Resource-based Models of Learning in STEM Disciplines (ED 214)Qualitative And Ethnographic Methods In Applied Social Science Research (CSHD 144) Principal Investigator: Mitch McVey Location: 200 Boston Ave., Suite 4700 Principal Investigator: EricTytell Location:200 Boston Ave., Suite 4800 Principal Investigator: Lawrence Uricchio Location:Science & Engineering Complex, 2nd floor Principal Investigator: Benjamin Wolfe Location: 200 Boston Ave. Abraham, J. K., Perez, K. E., & Price, R. M. (2014). The Dominance Concept Inventory: A Tool for Assessing Undergraduate Student Alternative Conceptions about Dominance in Mendelian and Population Genetics. CBELife Sciences Education, 13(2), 349358.Article Google Scholar American Association for the Advancement of Science (AAAS). (2011). Vision and change in undergraduate biology education. Washington, DC, 2011. . Accessed 20 Feb 2018.Au, T., Sidle, A., & Rollins, K. (1993). Developing an intuitive under-standing of conservation and contamination: Invisible particles as a plausible mechanism. Developmental Psychology, 29, 286299.Article Google Scholar Bassok, M., & Novick, L. R. (2012). Problem solving. In: The Oxford Handbook of Thinking and Reasoning Edited by Keith J. Holyoak and Robert G. Morrison. Oxford University Press.Book Google Scholar Beggrow, E., & Nehm, R. H. (2012). Students mental models of evolutionary Causation: Natural Selection and Genetic Drift. Evolution Education and Outreach. . Google Scholar Boone, W. J., Staver, J. R., & Yale, M. S. (2014). Rasch analysis in the human sciences. Dordrecht: Springer.Book Google Scholar Brigandt, I. (2016). Why the Difference Between Explanation and Argument Matters to Science Education. Science & Education, 25. Google Scholar Brownell, S. E., Freeman, S., Wenderoth, M. P., & Crowe, A. J. (2014). BioCore Guide: A Tool for Interpreting the Core Concepts of Vision and Change for Biology Majors. CBELife Sciences Education, 13(2), 200211.Article Google Scholar Campbell, C., & Nehm, R. H. (2013). Evaluating assessment quality in genomics and bioinformatics education research. CBE-Life Sciences Education, 12(3), 530541. Google Scholar Catley, K. M., & Novick, L. R. (2009). Digging deep: Exploring college students' knowledge of macroevolutionary time. Journal of Research in Science Teaching, 46(3), 311332.Article Google Scholar Coley, J. D., & Tanner, K. D. (2012). Common Origins of Diverse Misconceptions: Cognitive Principles and the Development of Biology Thinking. CBELife Sciences Education, 11(3), 209215.Article Google Scholar DeHaan R. L. (2011). Education Research in the Biological Sciences: A Nine-Decade Review. Paper presented at the Second Committee Meeting on the Status, Contributions, and Future Directions of Discipline-Based Education Research, Washington, DC, 2010. www7.nationalacademies.org/bose/DBER_DeHaan_October_Paper.pdf. Accessed 21 Mar 2019.Dirks C. (2011). The Current Status and Future Direction of Biology Education Research. Paper presented at the Second Committee Meeting on the Status, Contributions, and Future Directions of Discipline-Based Education Research, Washington, DC, 2010. www7.nationalacademies.org/bose/DBER_Dirks_October_Paper.pdf. Accessed 21 Mar 2019.Dobzhansky, T (1973). Nothing in Biology Makes Sense except in the Light of Evolution. The American Biology Teacher, Vol. 35 No. 3, Mar., 1973; (pp. 125129). Google Scholar Driver, R., Squires, A., Rushworth, P., & Wood-Robinson, V. (1994). Making sense of secondary science: Research into Childrens ideas. New York: Routledge. Google Scholar Fiedler, D., Sbeglia, G. C., Nehm, R. H., & Harms, U. (2019). How strongly does statistical reasoning influence knowledge and acceptance of evolution? Journal of Research in Science Teaching, 56(9), 11831206.Article Google Scholar Fisher, K. M., Williams, K. S., & Lineback, J. E. (2011). Osmosis and Diffusion Conceptual Assessment. CBELife Sciences Education, 10(4), 418429.Article Google Scholar Freidenreich, H. B., Duncan, R. G., & Shea, N. (2011). Exploring middle school students understanding of three conceptual models in genetics. International Journal of Science Education, 33(17), 23232349.Article Google Scholar Garvin-Doxas, K., & Klymkowsky, M. W. (2008). Understanding randomness and its impact on student learning: Lessons from the biology concept inventory (BCI). CBE Life Science Education, 7, 227233.Article Google Scholar Gerard, R. W., & Stevens, R. B. (1958). Concepts of Biology, National Research Council Publication 560 (). D.C.: National Academy Press. Washington. Google Scholar Goldberg, R. F., & Thompson-Schill, S. L. (2009). Developmental roots in mature biological knowledge. Psychological Science, 20(4), 480487.Article Google Scholar Ha, M., & Nehm, R. H. (2014). Darwin's difficulties and students struggles with trait loss: Cognitive-historical parallelisms in evolutionary explanation. Science & Education. Google Scholar Ha, M., Wei, X., Wang, J., Hou, D., & Nehm, R. H. (2019). Chinese pre-service biology teachers evolutionary knowledge, reasoning patterns, and acceptance levels. International Journal of Science Education, 41(5), 628651. Google Scholar Haslam, F., & Treagust, D. (1987). Diagnosing Secondary Students Misconceptions of Photosynthesis and Respiration in Plants Using a Two-Tier Multiple-Choice Instrument. Journal of Biological Education, 21. Google Scholar Imenda, S. (2014). Is there a conceptual difference between theoretical and conceptual frameworks? Journal of Social Science, 2(38), 185195. Google Scholar Inagaki, K., & Hatano, G. (1991). Constrained person analogy in young childrens biological inference. Cognitive Development, 6, 219231.Article Google Scholar Kalas, P., ONeill, A., Pollock, C., & Birol, G. (2013). Development of a Meiosis Concept Inventory. CBELife Sciences Education, 12(4), 655664.Article Google Scholar Kampourakis, K. (2013). Making sense of evolution. Oxford University Press.Kargbo, D. B., Hobbs, E. D., & Erickson, G. L. (1980). Childrens beliefs about inherited characteristics. Journal of Biological Education, 14(2), 137146.Article Google Scholar Kelemen, D., & Rosset, E. (2009). The human function compunction: Teleological explanation in adults. Cognition, 111, 138143.Kelemen, D., & DiYanni, C. (2005). 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