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Category Theory and Context: An Interview with Emily Riehl

Posted on August 19, 2017 (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/) by Beth Malmskog (https://blogs.ams.org/phdplus/author/bmalmskog/)



(https://i0.wp.com/blogs.ams.org/phdplus/files/2017/08/EmilyRiehl.jpg)

Emily Riehl

Emily Riehl (http://www.math.jhu.edu/~eriehl/) is an incredibly accomplished early-career mathematician, working at the interface of category theory and homotopy theory. She is also a stunning number of other things, including a creative interdisciplinary scholar (http://www.jhunewsletter.com/2016/10/06/professor-applies-queer-studies-to-mathematics/), working musician (https://unstraight.bandcamp.com), and high-level athlete (https://usafl.com/player/emily-riehl). A brief career outline: she did her undergraduate work at Harvard University, graduate work at Cambridge and the University of Chicago, was an NSF and Benjamin

Peirce Postdoctoral Fellow at Harvard from 2011-2015, and is currently an Assistant Professor at Johns Hopkins University. Emily has been awarded an NSF standard grant and a CAREER award to support her work. She is the author of 21 published research articles, two books (Categorical Homotopy Theory (http://www.cambridge.org/catalogue/catalogue.asp?isbn=9781107048454) and Category Theory in Context (http://store.doverpublications.com/048680903x.html)), and many other expository works. All this, and she also performs as a rock/alternative bass player and plays on the US women's national Australian Rules football team. I recently learned about Emily's work and profile while looking for women mathematicians to interview for the Association for Women in Mathematics newsletter. I thought maybe PhD+epsilon readers would also be interested to hear about an early-career mathematician doing some really cool things. The following interview is a compilation of email and Skype conversations from August 2017, while Emily was in Australia to compete in the AFL International Cup (http://www.afl.com.au/internationalcup).

A longer version of this interview will appear in an upcoming issue of the Association for Women in Mathematics newsletter (https://sites.google.com/site/awmmath/awm/newsletter).

Question: How and why did you get into category theory? Is there a basic result that you can share that gives the flavor of what you love about it?

Emily Riehl: For graduate school, I deferred from the University of Chicago for a year to go to Cambridge and do what they call a Part III. One of the courses they offered at Cambridge was in category theory, and I liked it instantly; I fell in love. I feel like it chose me as much as I chose it. And it was for the reason that I think that everyone chooses their field, ultimately: the proofs felt like the right way of thinking about mathematics. I felt right away that this is the sort of argument that I wanted to delve into.

Category theory can sound intimidating because it's highly abstract, but it's actually not that hard. Several of the most important definitions are quite elementary, and you can start stating and proving the theorems pretty quickly. Indeed, there's a common belief in category theory that once you understand the statement of the theorem, you can probably supply the proof yourself. Identifying the correct definitions is really the harder thing. The only reason that you typically don't learn category theory until graduate school is that it requires a rather high degree of mathematical sophistication to appreciate what it's for.

One of my favorite theorems in category theory is that right adjoints preserve limits—or, since you always get a dual theorem in category theory by simply "turning all the arrows around"—that left adjoints preserve colimits. This result specializes to explain why tensor products distribute over direct sums, why inverse images preserve intersections and unions while direct images only preserve unions, why quotients of topological spaces are formed by first identifying the appropriate points and then topologizing this quotient set. It's not so much that I appreciate having one proof instead of having to repeat the argument in each context but I feel that the category theoretic proof—which uses the fact that limits are characterized by a "mapping in" universal property, while colimits are characterized by a "mapping out" universal property—is the right one.

Q: You are early in your career, but you have written many, many papers, two books, and a lot of shorter expository work (like posts on the n-category cafe (https://golem.ph.utexas.edu/category/)). How do you do so much stuff? Do you have any insights into how/why you are so productive?

ER: I read Hardy's *A Mathematician's Apology* in high school and my main takeaway was from the forward written by C P Snow, who described Hardy's typical day: he devoted four hours in the morning, from 8-12, doing math, and then spent the afternoon watching cricket. It struck me as a particularly aspirational life style and so I've always focused more on working well than on working long hours. My main time management strategy is to start work on the thing that is due the soonest last, when I'll be the most focused. So, for example, if I have a referee report due in three months, I wait until almost three months have passed, and then start to read the paper. I also do the preparation for my teaching in the hour or hour and a half before class, in what often feels like a race to figure out how to prove all the theorems before I rush across campus. Occasionally this gets me in to trouble, for instance when I was trying set up a transfinite induction over the reals and couldn't understand why the intermediate stages were all "countable" (aside: I'm now firmly in the camp that believes that the axiom of choice is clearly true, while the well-ordering principle is clearly false). But this approach is very effective at reserving time for research and other long-term projects.

Q: What do you think are the best/worst parts of a life in math overall?

ER: The worst thing is how intellectually isolated we all are, how few people there are with whom we can share the insights that we find the most exciting, even among other mathematicians. For me personally I feel very frustrated that there is this huge part of my emotional life that most of the people whom I care about have no access to.

My favorite part of my job has always been giving talks. Research talks are my favorite, for the reasons alluded to above, but I also get some of that same thrill from giving colloquia or even from teaching. Even in high school, I enjoyed the performative aspects of lecturing. When I ran for student body president, my only real interest in the job was to give the campaign speech in front of the entire school.

Q: You begin your book *Categorical Homotopy Theory* with a quote from 'On proof and progress in Mathematics,' (http://www.ams.org/journals/bull/1994-30-02/S0273-0979-1994-00502-6/S0273-0979-1994-00502-6.pdf) by William Thurston: "...what we are doing is finding ways for *people* to understand and think about mathematics." How has Thurston's perspective on mathematics as a community endeavor, with human understanding at its core, influenced your mathematical life?

ER: I've wondered at various points whether I should be concerned about the amount of time I end up devoting to expository projects, such as the books, because it does certainly eat into research time. This is one of many instances where I've found Thurston's essay, which I've re-read a few times now, to be helpful for keeping these kinds of projects in perspective. The passage you quote above is his definition of mathematical progress, which he sees as much broader than simply proving theorems. I happen to particularly enjoy mathematical exposition, so I think it makes sense—or as the economists would say, is a comparative advantage—for me to play that role in the broader community.

I read from a different section of this essay—on the difficulties of mathematical communication—at the introductory meeting for an AMS sponsored Mathematics Research Community workshop in Homotopy Type Theory that I co-organized this past June as a way of framing our goals for the week, which were largely to provide an opportunity for people who are not currently a part of that community (e.g., because they're doing their PhD at a place that doesn't have a faculty member working in that area) to find their way in.

Q: What is next for you, in math and life?

ER: One of my favorite things about academia is that the job changes all the time, or at least it can, if you want it to. Right now I'm focused on growing the category theory group at Johns Hopkins and a few long-term research projects that I'd love to get through before an MSRI semester on Higher Categories and Categorification that will take place in 2020. In a decade's time, I hope I'm working on projects that I can't even imagine now and have found a way to be a part of larger mathematical and public conversations.

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3 Responses to Category Theory and Context: An Interview with Emily Riehl



John Q. Public says:

 $August\ 23,\ 2017\ at\ 7:46\ am\ (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/\#comment-2481)$

Interesting comments on "working well" as the goal (answer to the question on amount of artifacts created). Very nice insight.

Reply (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond) (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/category-and-context-an-interview-with-emily-riehl/?replytocom=2481 #respond(https://blogs.ams.org/phdplus/2017/08/category-and-context-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-interview-with-an-inte



Chris Jones says:

August 25, 2017 at 6:34 pm (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/#comment-2482)

Wow! Emily is truly an inspiring mathematician! Her deadline strategy sounds awfully similar to that of one of my mentors, Po-Shen Loh, who incidentally is another mathematician who manages an impressive set of activities.

Reply (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2482#respond)



Mozibur Ullah says:

December 1, 2017 at 5:40 am (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/#comment-2498)

Its great to see a mathematician that is an all-rounder unlike the typically skewed representations that movies favour portraying...

Reply (https://blogs.ams.org/phdplus/2017/08/19/category-theory-and-context-an-interview-with-emily-riehl/?replytocom=2498#respond)

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