Madhav Kaushish

Indian Address: K-24A Hauz Khas Enclave, New Delhi – 110016

Indian Phone: +91 99100 99677

US Address: 222 N 2nd Ave, Tucson, AZ – 85705

US Phone: +1 520 257 5518

University of Arizona Email: kaushish@math.arizona.edu

ThinQ Email: madhav@thinq.education

Department Website: http://math.arizona.edu/~kaushish

Education

PhD in Mathematics (Expected) | University of Arizona

2016 – 2021 (Expected)

Focus on Mathematics Education. Dissertation on Theory Building in Mathematics Education. Comprehensive Exam papers on Geometry Education and Probability Education available on my department website.

MS in Mathematics | University of Arizona

2016 – 2019

Thesis on Assumption Digging in Geometry Education available on my department website. The goal of this thesis was to develop materials for students to engage in the sort of thinking Hilbert did when he made Euclidean Geometry more rigorous, and try out those materials and see how students engage with them.

BA in Mathematics with High Honors | Oberlin College

2007 – 2011

Honors paper titled Fermat's Last Theorem and Unique Factorization

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Work Experience

Co-Founder | Inquire

2020 –

Started Inquire (www.inquire.education) with two other ThinQ team members. We run synchronous online workshops for students aged 12-18 which aim to develop the ability to think like mathematicians, scientists, philosophers, historians, and so on. Our long term goal is to also develop some asynchronous courses.

Graduate Teaching Assistant | Mathematics Department, University of Arizona

2016 –

Taught College Algebra, Precalculus, Calculus, Calculus 2, and Vector Calculus

Co-Founder and Member, Academic Leadership Team | ThinQ

2014 –

Started ThinQ (www.thinq.education) with a group of people committed to developing in students the ability to think like mathematicians, scientists, philosophers, historians, and so on.

Intern | 1st and 2nd Grade, Robison Elementary School, Tucson

January – May, 2018

Worked with the class teachers during Math and Science classes. The focus in the math classes was on counting and operations.

Consultant | MGIEP, UNESCO

2015 – 2016

Developed a plan to create a course aiming at getting students to think like mathematicians, scientists, philosophers, etc., and use those thinking abilities to evaluate issues of global concern. The course I developed the plan for was then given to ThinQ to develop.

Manager of Online Product Development and Mathematics Education Consultant | Universal Learn Today, India Today

2012 – 2015

Developed the curriculum for The Royal Academy in Bhutan, a new residential school started by the King. Worked with math teachers in various schools around India and Bhutan, including working with them in their classrooms and running workshops aimed at them. Managed a team of programmers who created various online products for the schools we worked with.

Founder and CEO | SmarterGrades

2011 – 2013

Initial funding was provided by a grant from Oberlin College and the Kauffman Foundation. The product was an online, adaptive, math skill testing product. I received an acquisition offer from Universal Learn Today and accepted it. However, the process took two years, by which time there were various competitors in the market. I had also gotten disillusioned with the goals of the project. Hence, I pulled out of the negotiations, got my employees alternative employment, and shut down the company.

Workshops and Talks

Course on Mathematical Theory Building

Jan-Feb 2020

Developed and ran a course on Mathematical Theory Building at two schools in Pune, India. This was done as the field work for my PhD thesis.

Workshop on Mathematical Theory Building | ThinQ

Summer 2018 & 2019

Ran workshops in two schools in Pune. The main aim of the workshops were to get students to construct mathematical theories, either by laying out systems of axioms and definitions, or digging back to axioms and definitions when presented with a claim and/or an argument for that claim. While students were the focus, the main reason the school administrations agreed to run the workshops was that teachers, who were watching and participating, would change how they approach math.

Graduate Colloquium | University of Arizona

Fall 2016 & Spring 2019

Gave talks on Mathematical Theory Building to other Graduate Students.

Mathematics Educator Appreciation Day | University of Arizona

January, 2017, 2018, & 2019

Gave talks on Mathematical Thinking in 2017 and 2018, and Theory Building in 2019. Received high feedback scores each year.

Inquiry and Integration in Education | ThinQ

December, 2015 & 2017

A select few participants of the annual online course run by ThinQ are invited every winter for a nine-day intensive, residential workshop in Pune. I have been involved in planning the workshop each year. I was only able to attend and facilitate the workshops in 2015 and 2017.

Workshop on Rational Inquiry and Integration | Royal Academy, Paro, Bhutan

May, 2015

As part of ThinQ, I was invited to run a workshop for the newly inducted teachers at The Royal Academy in Bhutan. The aim of the workshop was to elucidate some the aspects of education I had included in the curriculum Universal Learn Today had developed for them. Specifically, developing in them an understanding of what it means to think like mathematicians, scientists, philosophers, and so on.

Workshop on Rational Inquiry | IISER, Pune

May, 2014

Along with other members of ThinQ, I conducted a 5 day workshop on Rational Inquiry for 9th Grade students from various schools in Pune, hosted at IISER. The workshop was recorded and is available on ThinQ's YouTube channel.

Educational Materials Developed

Assumption Digging

I have developed materials on assumption digging, which means that given a claim and an argument for that claim, digging back to axioms and definitions. These materials are a part of my Master's Thesis. An example from Euclidean Geometry is starting with the claim: Triangles with the same base and between two parallel lines have the same area. While digging down, we have to define triangle, area and parallel

lines, amongst other concepts, and set up various axioms governing the world in order to arrive at the conclusion.

Extracting Definitions

This was an idea accidentally created when I walked into a classroom expecting students to have heard of the word 'circumscription.' When they didn't, I asked two of my fellow educators to keep two different definitions of the word in their mind. Students had to figure out what their definitions. The only help they had was that if they presented an example, the two people would respond with an affirmative if the object was circumscription by their definition.

Theory Construction in Discrete Geometry

Staring with the vaguely worded question - in a space with only six points, can every line be bisected? - students have to construct a set of axioms and definitions which allows them to engage with the question. Given that set of axioms and definitions, they can inquire more within the theory they have constructed.

Long-Form Problem Solving - Straight Lines and Intersections

This is a problem which, to solve, requires students to come up with various intermediate conjectures and theorems. This is a multi-session plan. A draft lesson plan and workbook can be found on my department website.

Concept Clarification - Parallel Lines

Clarifying the concept of parallel lines, and generalizing the notion outside of flat two-dimensional space. A draft lesson plan can be found on my department website linked to above.

Theory Construction in Science - Theoretical Anatomy

For this series of lessons, students have to assume they are Martians interested in inquiring about the working of the human body. They are not allowed to cut open the body - only observe and conduct non-invasive experiments. Given observations, they have to construct laws and models in order to explain them. Then, they evaluate those laws by looking for observations which may challenge them. A draft lesson plan and video can be found on my department website linked to above.

Video Lecture Series for Inquiry and Integration in Education

For every Learning Trigger of ThinQ's annual course, there is a series of videos which go along with it. Those videos are a conversation between K.P. Mohanan and me. These playlists can be found on my department website linked to above.

Probabilistic Thinking

I have developed materials for probabilistic thinking which can be found on my department website.

Courses Taken

The following are the courses I have taken as part of my PhD Program:

- Abstract Algebra (2016-17)

- Differential Geometry and Algebraic Topology (2016-17)
- Graph Theory (Spring 2017)
- Analysis (2017-18)
- Algebraic Number Theory (2017-18)
- Research in the Learning of Mathematics (Fall 2018)
- Neural Networks (Fall 2018)
- Qualitative Research Methods (Spring 2019)
- Cognitive Psychology (Spring 2019)
- Philosophy of Mathematics (Fall 2019)
- Research in the Teaching of Mathematics (Fall 2019)
- Theory of Probability (Fall 2020)