



Kaput Center for  
Research and Innovation in STEM Education

LARTS 114  
285 Old Westport Road  
Dartmouth, MA 02747, USA

## ANNUAL REPORT FY2023

KAPUT CENTER FOR  
RESEARCH AND INNOVATION IN  
STEM EDUCATION

MAY 31, 2023

## **Foreword**

All Academic Institutes and Centers at UMass Dartmouth are required to prepare an annual report for the fiscal year just completed, and this report fulfills this requirement for FY23.

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**UNIVERSITY OF MASSACHUSETTS DARTMOUTH  
KAPUT CENTER FOR RESEARCH AND INNOVATION IN  
STEM EDUCATION**

The Kaput Center for Research and Innovation in STEM Education is an interdisciplinary University Research Center that conducts innovative research in the teaching and learning of mathematics in all educational contexts. It is an academic Center located administratively with the School of Education in the College of Arts & Sciences.

**Chandra Orrill, Ph.D. – Director  
Kym Welty – Grants Support Specialist**

**EXECUTIVE BOARD FY23**

<p>Chairperson of the Board: Paul Fredette, <i>President &amp; CTO – Promptus Communications CTO - American Doctors Online</i> Term Expires: 11/24</p>	<p>James Burke, Ph.D. <i>Computer Science teacher, Somerset Berkley Regional High School</i> Term Expires: 5/25</p>	<p>Karen Chang, Ph.D. <i>Chemistry teacher at Naval Academy Preparatory School – NAPS</i> Term Expires: 3/25</p>
<p>Marylou T. Clarke, C.A.G.S. <i>Assistant Superintendent of Dartmouth Public Schools (Retired)</i> Term Expires: 05/25</p>	<p>Elizabeth Cullen <i>Director/Co-Founder Rhode Island STEAM Academy</i> Term Expires: 11/24</p>	<p>Robert Gegear, Ph.D. <i>Associate Professor of Biology, UMass Dartmouth</i> Term Expires: 9/25</p>
<p>Michael Goodman, Ph.D. <i>Senior Advisor to the Chancellor for Economic Development &amp; Strategic Initiatives, UMass Dartmouth</i> Term Expires: 9/25</p>	<p>Shakhnoza Kayumova, Ph.D. <i>Associate Professor of Science Education, UMass Dartmouth</i> Term Expires: 5/25</p>	<p>Trina Kershaw <i>Professor of Psychology, UMass Dartmouth</i> Term Expires: 9/25</p>
<p>Jay Wang, Ph.D. <i>Professor of Physics, UMass Dartmouth</i> Term Expires: 3/25</p>	<p>Dave Welty, Ph.D. <i>Biology/Chemistry teacher, Fairhaven High School</i> Term Expires: 5/24</p>	<p>Stephen Witzig, Ph.D. <i>Assistant Professor of Science Education, UMass Dartmouth</i> Term Expires: 10/24</p>

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## **Mission**

The Kaput Center for Research and Innovation in STEM Education at the University of Massachusetts Dartmouth was established on March 1<sup>st</sup>, 2007. The Center was established in the spirit and vision of James J. Kaput, whose innovative thinking and leadership inspired many in the field of mathematics education. The purpose of this Center is to provide a focus and support for sustained investigation of foundational issues in the field of STEM education, issues that will be chosen to enhance and deepen ongoing research by its members and associates. The Center is an interdisciplinary research unit where fundamental problems in STEM education are studied, discussed and analyzed through conferences, interdisciplinary colloquium series, basic research and development, commissioned reports, and think-tank meetings.

This document reports the progress toward the fulfillment of this mission for the period ending July 31, 2023, which is Fiscal Year 2023. This document was prepared by Dr. Chandra Orrill, Director of the Center with support from Kimberly Welty, Grant Support Specialist. Because of the director's departure from the university, the report was completed in May 2023, thus some budget details may change slightly by the end of the fiscal year.

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## **Introduction**

The Kaput Center for Research and Innovation in STEM Education at the University of Massachusetts Dartmouth (hereon called the “Kaput Center”) was founded by Professors Blanton, Hegedus and Moreno-Armella of the Department of Mathematics. The Kaput Center grew out of Professor Jim Kaput’s aim of democratizing mathematics for all learners.

President Jack Wilson approved its establishment on February 14<sup>th</sup>, 2007 and its was officially established by Dr. Anthony Garro, Provost of the University of Massachusetts Dartmouth, on March 1<sup>st</sup>, 2007.

Dr. Stephen Hegedus, Professor in the Department of Mathematics, was appointed the Center’s first Director by Provost Garro and Chancellor MacCormack.

During the initial period of its establishment (March – June of FY07) the Director and the founding faculty established an Executive Board and External Advisory Board. Projects of the Mathematics Education faculty were transferred to the Center and an agenda for the operation and events of the Center for the upcoming years was established.

In 2014, Professor Hegedus resigned from UMass Dartmouth, leaving the Kaput Center in the hands of Professors Goodman, Güçler, and Orrill serving as Interim Directors while a permanent director was sought. The search for a permanent director for the Kaput Center in FY 2015 was not successful, thus the leadership structure remained the same for FY2016. In FY2017, Professor Walter Stroup joined the leadership team and Professor Goodman stepped into the role of Chairperson of the Executive Board without additional duties. At the end of FY2017, an internal search was conducted and Professor Chandra Orrill was named the Director of the Kaput Center effective July 1, 2017. Professor Goodman continued serving in his capacity as Chairperson of the Board. Professors Orrill and Goodman resigned from their respective positions in July 2020. At that time, the Kaput Center was put on hiatus because of the limitations of trying to operate during the COVID shutdown. In September 2021, Dr. Orrill was reinstated as the director of the Kaput Center. On May 31, 2023, Dr. Orrill left UMass Dartmouth.

This report documents the ongoing work of the Kaput Center through FY2023.

## Directors' End-of-Year Report FY2023

FY23 was a very successful year for the Kaput Center as things returned to a more normal state following the pandemic. We continued to offer the colloquium series online, which resulted in much higher levels of participation than in previous years. In addition, we were able to hold our first STEM4Girls event since the pandemic and we were able to participate in one school district's STEM Day.

The Kaput Center received its first substantial external support for STEM4Girls. The 2022 Jacobs Family Donor Advised Fund of the SouthCoast Community Foundation kindly directed \$30,000 to support the growth of STEM4Girls. This funding will allow us to better serve over 200 girls in the community for the next few years. We appreciate this award tremendously.

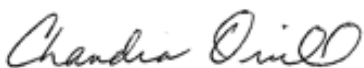
In FY 2023, Executive Board Members Stephen Witzig and Robert Gegear, along with Biology Professor Kathryn Kavanagh received nearly \$600,000 from the National Science Foundation to support faculty throughout the state to learn about doing citizen science in their coursework. In addition to this grant, Dr. Kayumova also has two grants under review.

We added three new Executive Board Members in FY23. Dr. Michael Goodman, Senior Advisor to the Chancellor for Economic Development & Strategic Initiatives, returned to the board. We were also delighted to continue expanding the breadth of the Board's expertise by welcoming Dr. Trina Kershaw from Psychology and Dr. Robert Gegear from Biology.

The Kaput Center began its periodic review in FY22. The review should conclude in May 2023. This is not a normal timeline and it is not a reflection of any part of the Kaput Center that the timeline is off. We are cooperating with the Dean's office to complete the review as quickly as possible. This review will provide us with critical feedback on our work toward our mission and toward the university's goals. Based on conversations with the Dean's office and Provost's office in Summer 2022, we have already made changes, including revisiting our advisory board. While it is still international, it is now more representative of STEM, rather than focusing mainly on mathematics education. It is also much smaller, which we believe will help us better engage the members to utilize their expertise. We have also updated the bylaws to more accurately reflect the ways in which the Kaput Center operates.

The Kaput Center is a reflection of its people. As such, the STEMester in Review continues our tradition of having a variety of authors share their insights about events that happened this year.

This will be my last Director's update as I have resigned from my position at UMass Dartmouth. It has been a pleasure stewarding the Kaput Center. I have learned a lot and had a lot of fun. I look forward to seeing what the next director does with it.



Chandra Orrill  
Director

## **Kaput Center Infrastructure**

### ***Executive Board & Duties (from the newly approved Bylaws)***

1. **Membership and Eligibility.** The Executive Board will consist of the Director of the Kaput Center, ex-officio, and no more than fifteen other individuals who shall be faculty members at an accredited institution of higher education; qualified professional practitioners with a documented record of scholarship or professional experience in education or educational policy, particularly, but not constrained to, STEM education research; or drawn from positions of leadership in the public, non-profit, and private sectors. At least 50% of the Executive Board members will be employees of UMass Dartmouth. The Director will invite and accept nominations for members of the Executive Board for review by the Executive Board. All members of the Executive Board agree to execute the mission of the center in collaboration with other Executive Board members and abide by the policy on center operations. A full list of members will always be displayed in the Kaput Center and included in the Annual Report.

2. **Chair.** The Executive Board will elect one member to serve as the Chair of the Executive Board for each year. This position will be voted on at the last meeting of each academic year to be active at the first meeting of the new academic year. The candidate receiving the most votes will be the Chair. The Chair will work with the Kaput Center Director to build meeting agendas and will serve as an advisor to the Director on issues that are timely in nature.

3. **Meetings.** The Executive Board will be convened quarterly by the Director of the Kaput Center. The Director of the Kaput Center must notify all members of the Executive Board of the time, date, and place of all quarterly meetings at least one week prior to said meetings. A simple majority of the Executive Board shall constitute a quorum. Meetings will be run subject to Robert's Rules of Order. The Provost and the Chancellor of the University of Massachusetts Dartmouth, as well as the Dean of the College of Arts and Sciences, can attend all Executive Board Meetings, although they are not members of the Executive Board.

4. **Powers.** The Executive Board shall exercise the following powers and authority:

- to review the Director's quarterly update on research projects, service agreements, sponsored research agreements, and other activities,
- to review the Director's quarterly statement of the budget for the Center and to make recommendations for expenditures and encumbrances from the budget,
- to approve or reject nominations of individuals for appointment to the Center as Research Associates or Visiting Research Associates,
- to approve or reject nominations of individuals for appointment to the Executive Board,
- to approve or reject the Director's recommendations for creating or discontinuing functional Divisions of the Kaput Center,
- to approve or reject the Director's nominations of individuals for the appointment and removal of Heads of Divisions,
- to review, recommend, and approve any policies governing the Center's operations as specified in the Mission Statement and By-Laws,



- to approve or amend the Director’s proposed annual report, financial statement, and proposed budget before it is submitted to the Provost or other officers of the University,
- to approve all recommendations from standing committees of the Executive Board,
- to advise and assist with graduate student recruitment strategies.

5. Approvals. A simple majority of those members present and voting shall be sufficient to grant or withhold the approval of the Executive Board on all matters, except as specified elsewhere in the Mission Statement and By-Laws.

6. Membership shall be for three (3) years and renewable.

### ***Advisory Board & Duties***

1. Purpose. The Kaput Center is linked to the wider community through an Advisory Board. The Advisory Board shall be composed of individuals, appointed by the Director, who are drawn from positions of leadership in the public, non-profit, and private sectors. The Executive Board shall be notified of any additions to the Advisory Board at each quarterly meeting. The Advisory Board will assist in setting the Center’s research agenda and in developing research resources. The Advisory Board will also advise and assist the Director and Executive board in developing strategic plans to achieve its mission that responds to educational need locally, nationally and internationally in the field of STEM education. The Advisory Board members are considered advocates of the Center, promoting the work of the Center and establishing new associations with leaders in STEM education research and innovation.

### ***Research Scientists, Associates & Staff***

As part of the bylaws editing process, we revisited the Research Scientists, Associates, and Staff and decided to simplify the structure for associates of the Center. There are now three primary designations: Research Scientists, Visiting Research Scientists, and Research Assistants. They are described as follows:

a. Research Scientist: (1) a tenured or tenure-track faculty member at the University of Massachusetts Dartmouth, who is developing or executing a research, public service, or educational project under the auspices of the Kaput Center, or (2) a qualified professional practitioner, who is locally developing or executing a research, public service, or educational project under the auspices of the Kaput Center,

b. Visiting Research Scientist: (1) any faculty member at an accredited college or university, who is developing or executing a research, public service, or educational project related to the mission of the Kaput Center and will have a physical presence at the Kaput Center or (2) a qualified professional practitioner, who is developing or executing a research, public service, or educational project related to the mission of the Kaput Center and is visiting the Center. Visiting Research Scientists are expected to make a substantive contribution to the Kaput Center in collaboration with Center faculty and students. Appointment to the position of Visiting Research Scientist requires the approval of the Kaput Center Executive Board.

c. Research Assistant: (1) any student accepted into a graduate program at the University of Massachusetts Dartmouth who is appointed as a Research Assistant to a Center-based grant-funded project.

### ***Physical Layout & Equipment***

The Kaput Center was moved to Room 114 in the LARTS building on the UMass Dartmouth campus in Fall 2019. While this move was important to move the work of the Center forward, it resulted in a dramatic reduction in space as well as liquidation of many of our older technologies. At the end of FY2020, the following technologies are housed in the Kaput Center:

- 7 Apple Laptop computers for use in research projects and demonstrations
- iPads for use on research projects for use in research projects and demonstrations
- 6 Chromebooks for use in research projects and demonstrations
- 11 Photon Robots
- HD/DV cameras
- Wireless lavalier microphones
- 4 audio recorders
- Augmented reality sandbox
- A variety of common “Makerspace” technologies including Arduinos, robots, Makey Makey, and Raspberry Pis

Some of these materials are housed in the Kaput Center without being the property of the Kaput Center (e.g., the Augmented Reality Sandbox and the Photons), but they are available for use by any faculty or students affiliated with the Center.

Kaputcenter.org, our website, went live in fall 2018. We updated this URL for an additional five years in FY 23.

In addition to the devices, the Kaput Center has a large library that supplements the Campus library facility and which includes a small sampling of journals and books relevant to STEM Education. The Center’s library includes journals and books focused on: Mathematics Education, Anthropology/Evolutionary Theory, Cognitive Psychology/Science, Representation theory, Computer Science and Design, Learning Sciences, Linguistics and Discourse Analysis, Complexity Theory, Mathematics, Philosophy, Socio-Cultural Studies, Curriculum Design, and Quantitative and Qualitative Methodology. The books are indexed in Libib, which makes it possible to see the holdings for the Kaput Center on the Web:  
<https://www.libib.com/u/kaputcenter>

## Summary of Fiscal Activity

We report in detail here the Center's main operational budget and not the revenue/cost structure of externally funded grants. Total operational budget for FY23 was \$31,597.05 with operational expenses of \$41,813.77.

**Table 2: Revenue & Costs for FY23**

<b>Expense Type</b>	<b>Description</b>	<b>Amount</b>
<b>Revenue</b>	University Support (Salaries, Fringe & Operational Budget)	\$31,597.05
	Indirect Revenue	\$23,392.42
	<b>Total Revenue</b>	\$54,989.49
<b>Direct Expenses</b>		
<b>Payroll</b>	Total Payroll FY22	\$ 16,280.71
	Fringe for FY22	\$ 8,886.74
	<b>Total Payroll FY22</b>	<b>\$ 25,167.45</b>
<b>Non-Payroll</b>		
Office/Admin Supplies	<b>Total Office &amp; Admin Supplies</b>	<b>\$4,034.48</b>
Employee Related Expenses	Travel	\$187.39
	<b>Total Employee Related Expenses</b>	<b>\$ 187.39</b>
Non-Employee Exp	Travel	\$ 0.00
	Consulting	\$1,699.20
	Honoraria/Performers	\$ 3,200.00
	<b>Total Non-Employee Expenses</b>	<b>\$3,699.20</b>
Facility & Ops	Food & Beverage	\$ 21.39
	Rchg Admin Exp	\$ 4.50
	Subscriptions	\$903.81
	Research Supplies	\$ 1,299.22
	General Recruitment (CORI Fees)	\$60.00
	Books - Non Library	\$409.49
	<b>Total Facility &amp; Operations</b>	<b>\$ 2,698.41</b>
Printing	Copier Expense	\$1,383.32
	<b>Total Printing Expenses</b>	<b>\$1,383.32</b>
Conference Misc & Temp Space	<b>Total Conference Misc &amp; Temp Space Expenses</b>	<b>\$1,986.00</b>
IT Equipment	<b>IT Equipment</b>	<b>1,838.98</b>
	<b>Total Postage &amp; Freight</b>	<b>\$ 0.00</b>
	<b>Total Telecom Services Voice</b>	<b>\$818.54</b>
	<b>Total Non-Payroll</b>	<b>\$16,646.32</b>
	<b>Total Direct Expenses</b>	<b>\$41,813.77</b>

## Functional Areas of Operation

### *Research & Development*

*Addressing Mission Need: Provide a focus and support for sustained investigation of foundational issues in the field of mathematics education ...*

The faculty and staff of the Kaput Center and their associates continue to conduct cutting-edge research in mathematics education focusing on the following core areas:

- Enhancing mathematical communication in K-16 classrooms
- Transforming teaching practice across districts
- Addressing the needs of all learners in STEM Education
- Teacher knowledge and teacher professional development
- District-wide improvement of mathematics and science teaching in elementary and middle grades
- Teaching and learning mathematics at the undergraduate level

The Kaput Center ends FY 2023 with 7 active grants.

**CAREER: Analyzing the Nexus between Advantaged Social Positioning and Science Identity Development Among English Language Learners.** This project was funded by the National Science Foundation with a start date of September 2017. This grant to Shakhnoza Kayumova explores how to support students in developing as STEM learners while they are also learning to speak English. The goal of the grant is to better support teachers to support students who are grappling with language acquisition.

**Usable Measures of Teacher Understanding: Exploring Diagnostic Models & Topic Analysis as Tools for Assessing Proportional Reasoning for Teaching.** This project is housed at University of Southern California with Yasemin Copur-Gencturk as the PI. Chandra Orrill serves as a Co-PI and as the lead project person at UMass Dartmouth. This is an NSF-funded project. In this project, we are creating an assessment of teacher knowledge for proportional reasoning. We aim to measure content knowledge (CK) and pedagogical content knowledge (PCK) using emerging psychometric models including Diagnostic Classification Models and Topic Models. (Ending summer 2023)

**Advancing Middle School Teachers' Understanding of Proportional Reasoning for Teaching.** This is an IES-funded research grant housed at University of Southern California with Yasemin Copur-Gencturk as the PI. Chandra Orrill serves as a Co-PI and as the lead project person at UMass Dartmouth. In this project, we are attempting to create online professional development for proportional reasoning. We are focused on both the mathematical knowledge (CK) and the strategies teachers use to teach proportions (PCK). The resulting PD will be entirely online with a virtual facilitator and an assessment system that places teachers into submodules based on their abilities. (Ending summer 2023)

**Computational Thinking Counts in Elementary Grades: Powerful STEM Teaching and Learning for the 21<sup>st</sup> Century.** This NSF-funded research grant is led by Chandra Orrill (PI), with Shakhnoza Kayumova and Ramprasad Balasubramanian as co-PIs. The research team seeks to help elementary school teachers engage their students in computational thinking, the kind of thinking that computer programmers use. For example, students will be challenged to think about problem solutions in ways that would allow a computer to solve them; create solutions that require a series of ordered steps to carry out; identify, analyze, and implement solutions that are efficient, effective, and creative; and use models and simulations to represent data.

**EAGER: SaTC AI-Cybersecurity - Opening Doors for Cybersecurity & AI: An Interdisciplinary Approach to Engaging Middle School Students.** This NSF-funded grant is led by Chandra Orrill (PI) with Shakhnoza Kayumova and Pratim Sengupta (University of Calgary and Kaput Center Advisory Board member) serving as Co-PIs. We are exploring what middle school students should know at the intersection of cybersecurity and how we can support them in learning those things. To this end, we have developed a think tank comprised of cybersecurity researchers, cybersecurity and AI professionals, K-12 teachers, and educational researchers. We are looking at the big ideas this group developed to create a pilot unit of instruction for middle school students. We are also creating a survey for middle school students to be used as a baseline for determining what those students know about this area.

**Rational Numbers Playground: Applying and Refining a Model for Dynamic, Discussion-Based PD for Fractions, Ratios, and Proportions.** This NSF-funded grant is a collaboration between Chandra Orrill (PI), Rachael Brown at Penn State Abington, and Allan Cohen at the University of Georgia. It is focused on the development of a model for professional development that supports teachers in transferring their learning to their mathematics classrooms. Activities in the PD include Exploring the mathematics using playful engagement with dynamic tools, making Connections between that exploration and traditional models of the mathematical ideas, and Applying the learning to plans for teaching in classrooms. For this study, the focus is on specific aspects of fractions and proportions. As part of the research, we are also developing Topic Modeling, which is a quantitative approach to analyze conversations from the professional development as a tool for assessing learning.

**Connecting Undergraduates to Biodiversity Instruction through Citizen Science (CUBICS).** Stephen Witzig (PI), Robert Gear, and Kathryn Kavanagh received this NSF grant focused on professional development for science faculty. The program will be centered on socioscientific issues and incorporate of citizen science into college classrooms. The goal is to increase student interest in science and to promote retention in science. The project will specifically focus on biodiversity and climate change as themes for the professional development, which will help to further develop faculty members' expertise in these areas.

## ***Symposium & Colloquium Series***

*Addressing Mission Need: The Center is an interdisciplinary research unit where fundamental problems in mathematics education will be studied, discussed and analyzed through conferences, interdisciplinary colloquium series ...*

We continued our virtual colloquium series. This year, we tried something new – we introduced two new categories of colloquia. In addition to our traditional research-focused colloquium, we added the Big Idea and Student to Scholar formats. In Big Idea colloquia, leaders in the field are invited to share a big idea they have been thinking about. We had two of these. The first was Yasmin Kafai who spoke on Computational Thinking 3.0, focused on her ideas about what the upcoming ways of framing computational thinking might be. In the second, David Williamson Schaffer introduced us to Quantitative Ethnography, which is the emerging branch of research methodologies that tackle the task of analyzing very large sets of qualitative data. Our Student to Scholar series was opened with Travis Weiland, a graduate of our program who is in his second faculty position since graduation. He shared a wealth of information about how to succeed as a PhD student and early career faculty member. We also hosted one traditional format colloquium in which Dionne Cross Francis shared her research about teacher professional development, including some fascinating work she recently completed in Ghana. Full abstracts of the talks can be found in Appendix B.

Attendance at this year’s colloquia ranged from 12 to 60 and we saw considerable variability in the make-up of the audience as shown in the table below.

Data on Attendance at Colloquia FY23

Speaker	Grad Students	Prospective Students	Faculty	Executive Board	Advisory Board	Other
Francis	5	1	2			5**
Kafai	11	1	4*	5	2	18
Weiland	13	1	3*	6	1	1
Schaffer	9	1	2*	4	0	2

\*For Kafai and Weiland, one faculty member is counted in both Faculty and Executive Board.

For Schaffer, 2 people are counted in both columns.

\*\*For Francis, data were not collected the same as subsequent colloquia, thus there are relatively more “other” participants.

All of the past Colloquium talks are available on the Kaput Center YouTube channel and are accessible through the Kaput Center Website.

## ***STEM4Girls***

We held the first STEM4Girls since spring 2019. We had 119 registrations and 91 actual attendees. Five school districts and one Girl Scout troop sent groups of girls plus we had 10 register online from around the area. We welcomed Megan Winton opened the session talking about her work as a shark researcher. This was followed by a fun warm-up session from Our Sisters School. From there, students attended two of the 15 workshops offered by our experts. At lunch we offered some hands-on experiences with robots and Norbet, an Eastern Box turtle on loan from our partner, the Lloyd Center for the Environment. The day ended with a high-energy session led by STEAM the Streets focused on STEM-related careers in music.

We are absolutely thrilled to announce that the 2022 Jacobs Family Donor Advised Fund of the SouthCoast Community Foundation has donated to the Kaput Center to not only continue, but also grow STEM4Girls in the coming years.

## ***Supporting the PhD Program***

*Addressing Mission Need: The Center is an interdisciplinary research unit where fundamental problems in mathematics education will be studied ...*

The Department of STEM Education and Teacher Development was able to start the STEM Education Ph.D. program in Fall 2018. The Kaput Center supports the program through the colloquium series. We also make available key Handbooks and other materials, such as the APA guide for writing papers. With our move to campus, we were able to use an ID reader to grant all the doctoral students and faculty access to the Kaput Center any time they needed it, thus making the physical materials in the Kaput Center more accessible. Ph.D. students use these materials, such as video cameras and tripods, in their own research projects.

One project undertaken this year was to organize the books and journals to make them more accessible for the students.

## ***K-12 Outreach***

In FY23, the director of the Kaput Center, along with graduate students Ali Asif, Hamza Malik, and Rohini Thapa, attended the STEAM Fair at Falmouth High School. We were able to share our robots and Norbet the turtle with many excited families as they learned about computational thinking and how to save the turtles.

## Grant Proposal Activity

### ***Funded Proposals*** (bolded names indicate Research Scientists in the Kaput Center)

Title: Usable Measures of Teacher Understanding: Exploring Diagnostic Models & Topic Analysis as Tools for Assessing Proportional Reasoning for Teaching

PI: Yasemin Copur-Gencturk (Univ of Southern CA)

Subaward PI: **Chandra Orrill** (PI on UMassD Subaward)

Co-PIs: Allan Cohen (Univ of Georgia) & Jonathan Templin (Univ of Kansas)

Funding Agency: National Science Foundation

Total Award: \$2.1 million

UMassD Amount: \$377,973

Project Dates: 6/1/2018-5/31/2023

Title: Advancing Middle School Teachers' Understanding of Proportional Reasoning for Teaching

PI: Yasemin Copur-Gencturk

Subaward PI: **Chandra Orrill** (PI on UMassD Subaward)

Co-PIs: Benjamin Nye (USC), Allan Cohen (UGA)

Funding Agency: Institute for Educational Sciences

Total Award: \$1,471,420

UMassD Amount: \$308,851

Project Dates: 7/1/2018-6/30/2023

Title: CAREER: Analyzing the Nexus between Advantaged Social Positioning and Science Identity Development Among English Language Learners

PI: **Shakhnoza Kayumova**

Funding Agency: National Science Foundation, CAREER program

Amount: \$779,000

Project Dates: 9/1/2017-8/31/2023

Title: Computational Thinking Counts in Elementary Grades: Powerful STEM Teaching and Learning for the 21<sup>st</sup> Century

PI: **Chandra Orrill**

Co-PIs: **Shakhnoza Kayumova** & Ram Bala (Computer Science)

Funding Agency: National Science Foundation

Total Award: \$2,116,315

Project Dates: 1/1/2020 – 12/31/2023

Title: EAGER: SaTC AI-Cybersecurity - Opening Doors for Cybersecurity & AI: An Interdisciplinary Approach to Engaging Middle School Students

PI: **Chandra Orrill**

Co-PIs: **Shakhnoza Kayumova**, Pratim Sengupta (Univ of Calgary)

Funding: National Science Foundation

Amount: \$299,483

Project Dates: 9/1/2021-8/31/2023



Title: Rational Numbers Playground: Applying and Refining a Model for Dynamic, Discussion-Based PD for Fractions, Ratios, and Proportions

PI: **Chandra Orrill**

Co-PI Rachael Brown (Penn State Abington) & Allan Cohen (Univ of Georgia)

Funding: National Science Foundation

Amount Requested: \$980,175

Project Dates: 8/2022-7/2026

Title: Connecting Undergraduates to Biodiversity Instruction through Citizen Science (CUBICS)

PI: **Stephen Witzig**

Co-PI **Robert Gegear**, Kathryn Kavanagh

Funding: National Science Foundation

Amount Requested: \$599,926

Project Dates: 2/2023-1/2026

### **Grants Under Review 2022-23:**

Title: STEMcyclists: Black and Brown Youth Transforming STEM via Bikes

PI: **Shakhnoza Kayumova** (under University of Buffalo as lead institution)

Funding: National Science Foundation

Amount Requested: \$201,402

Project Dates: 1/2024 – 12/2026

Title: Collaborative Research: IMPACT SCALE (PK-5) Increasing Massachusetts Partnerships for Advancing Computational Thinking through Sustaining Cultural & And Linguistic Educational-Practices

PI: **Shakhnoza Kayumova** (collaborative grant with Worcester Polytechnical University)

Funding: National Science Foundation

Amount Requested: \$

Project Dates: 1/2024 – 12/2026

### **Grants Not Funded 2022-23**

Title: Collaborative Research: CS through STEM RPP - Engaging Teachers in a Pedagogical Shift to Broaden CS Education in Middle School

Co-PIs: **Robert Gegear**, **Shakhnoza Kayumova** (subaward with WPI as lead institution)

Funding: National Science Foundation

Amount Requested: \$338,697

Project Dates: 9/2022-8/2025

Title: Kids Engaged in Environmental Literacy (KEEL)

Co-PIs: **Stephen Witzig**, Katherine Kavanagh

Funding: National Science Foundation

Amount Requested: \$299,968

Project Dates: 7/2022 – 6/2024

Title: Next Generation Mentoring: Supporting Retention and Persistence of Diverse Students in Undergraduate Engineering

PI: Sukalyan Sengupta

CoPIs: **Chandra Orrill, Trina Kershaw**

Funding: National Science Foundation

Amount Requested: \$199,993

Project Dates: 9/2023 – 8/2025

## Publications of the Kaput Center (2018-2023)

### 2018

- Bazzul J., & Kayumova, S. (2018). The ethical subject of science education: Toward different ethico-political frontiers for twenty-first century science education. In G. Reis, M. Mueller, R. Gisewhite, L. Siveres, & R. Brito (Eds.), *Sociocultural perspectives on youth ethical consumerism. Cultural Studies of Science Education*: (pp. 101-114). Springer: Dordrecht, Netherlands.  
[https://doi.org/10.1007/978-3-319-65608-3\\_7](https://doi.org/10.1007/978-3-319-65608-3_7)
- Brown, R. E., Orrill, C. H., & Park, J. F. (2018). Knowledge resources for proportional reasoning in dynamic and static tasks. In T. E. Hodges, G. J. Roy, & A. M. Tyminski (Eds.), *Proceedings of the 40<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 488-491). Greenville, SC: University of South Carolina & Clemson University.
- deAraujo, Z., Orrill, C. H., & Erikson, J. (2018). Designing communication-rich problem-centered mathematics professional development. *International Journal of Mathematical Education in Science and Technology*, 49(3), 323-340. doi: 10.1080/0020739X.2017.1373153
- Emre-Akdoğan, E., Güçler, B., & Argün, Z. (2018). The development of two high school students' discourses on geometric translation in relation to the teacher's discourse in the classroom. *Eurasia Journal of Mathematics, Science and Technology Education*, 14(5), 1605-1619.  
<https://doi.org/10.29333/ejmste/84885>
- Emre-Akdoğan, E., Güçler, B., & Argün, Z. (2018). One high school student's discursive development on reflection in relation to instruction from a commognitive perspective. Full research paper published in the online proceedings of the first International Commognitive Workshop, Haifa, Israel: The Technion.
- Emre-Akdoğan, E., Güçler, B., & Argün, Z. (2018). One student's discursive development on rotation in relation to instruction from a commognitive perspective. In Bergqvist, E., Österholm, M., Granberg, C., & Sumpter, L. (Eds.). *Proceedings of the forty-second annual meeting of the International Group for the Psychology of Mathematics Education* (Vol. 2, pp. 403-410). Umeå, Sweden: PME.
- Jacobson, E., Lobato, J., & Orrill, C. H. (2018). Middle school teachers' use of mathematics to make sense of student solutions to proportional reasoning problems. *International Journal of Science and Mathematics Education*, 16(8), 1541-1559. doi: 10.1007/s10763-017-9845-z
- Kayumova, S., Avraamidou, L., & Adams, J. D. (2018). Science education: Diversity, equity and the big picture. In *Critical Issues and Bold Visions for Science Education* (pp. 285-297). Brill Sense.
- Kayumova, S., McGuire, C., & Cardello, S. (2018). From empowerment to response-ability: Rethinking socio-spatial, environmental justice, and nature-culture binaries in the context STEM education. *Cultural Studies of Science Education*. DOI: 10.1007/s11422-018-9861-5.
- Kayumova, S., & Tippins, D. (2018). Obsessed with accountability? Science teachers under the microscope. In L. Bryan & K. Tobin (Eds), *Thirteen questions in science education*. Peter Lang: New York.
- Kayumova, S., Zhang, W., & Scantlebury, K. (2018). Displacing and Disrupting Colonizing Knowledge-Making-Practices in Science Education: Power of Graphic-Textual Illustrations. *Canadian Journal of Science, Mathematics and Technology Education*, 18(3), 257-270.

- McGuire, C. J., & Kayumova, S. (2018). Increased exposure to environmental hazards: An opportunity for science, technology, engineering, and math education. *Environmental Justice*, 11(5), 198-201.
- Orrill, C. H., & Brown, R. E. (2018). Examining teacher knowledge resources for proportional reasoning visually. In T. E. Hodges, G. J. Roy, & A. M. Tyminski (Eds.), *Proceedings of the 40<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 504-507). Greenville, SC: University of South Carolina & Clemson University.
- Orrill, C. H., & Millett, J. (2018). In-service teachers' abilities to make sense of fixed number of variable sized parts tasks. In T. E. Hodges, G. J. Roy, & A. M. Tyminski (Eds.), *Proceedings of the 40<sup>th</sup> annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 508-511). Greenville, SC: University of South Carolina & Clemson University.
- Petrosino, A. J., Sherard, M. K., Harron, J. R., & Stroup, W. M. (2018). Using collaborative agent-based computer modeling to explore tri-trophic cascades with elementary school science students. *Creative Education*, 9(4), 615-624.
- Santavicca, N. and Terrell, K.L. (2018). The ELL shadowing protocol: Providing voice for ELLs in the classroom. In F. Copeland and S. Garton (Eds.), *Voices from the TESOL classroom: Participant inquiries in young learner classes*, pp.111-119. Alexandria, VA: TESOL International Association.

## 2019

- Bazzul, J., Tolbert, S., & Kayumova, S. (2019). New materialisms and science classrooms: Diagramming ontologies and critical assemblies. In *Material practice and materiality: Too long ignored in science education* (pp. 117-130). Springer, Cham.
- Brown, R. E., & Orrill, C. H. (2019). An exploration of teachers' abilities to identify proportional situations and make sense of students' thinking. In S. Otten, A. G. Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.), *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 704-708). St Louis, MO: University of Missouri.
- Brown, R. E., Weiland, T., & Orrill, C. H. (2019). Mathematics teachers' use of knowledge resources when identifying proportional reasoning situations. In *International Journal of Science and Math Education*. <https://doi.org/10.1007/s10763-019-10006-3>
- Emre-Akdoğan, E., Güçler, B., & Argün, Z. (2019). High school students' development of mathematical discourses on geometric reflections in relation to instruction, *Journal of Uludag University Faculty of Education*, 32(2), 467-496.
- Kayumova, S. (2019). Engaging with Complexities and Imaging Possibilities Across the Boundaries of STEM. In *Critical, Transdisciplinary and Embodied Approaches in STEM Education* (pp. 351-357). Springer, Cham.
- Kayumova, S., McGuire, C. J., & Cardello, S. (2019). From empowerment to response-ability: Rethinking socio-spatial, environmental justice, and nature-culture binaries in the context of STEM education. *Cultural Studies of Science Education*, 14(1), 205-229. doi: 10.1007/s11422-018-9861-5.
- Kayumova, S., & Bazzul, J. (2019). The Ethical and Sociopolitical Potential of New Materialisms for Science Education. In *Material practice and materiality: Too long ignored in science education* (pp. 51-64). Springer, Cham.

- Nagar, G. G., Orrill, C. H., & Hegedus, S. (2019). High school mathematics teachers' discernment of variance and invariance in a dynamic geometry environment. S. Otten, A. G. Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.), *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 767-771). St Louis, MO: University of Missouri.
- Orrill, C. H., Brown, R. E., Burke, J. P., Epstein, M., & Harper, A. (2019). Quantity: It may not be as easy as it appears. In S. Otten, A. G. Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.), *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 777-778). St Louis, MO: University of Missouri.
- Orrill, C. H., & Hill, J. R. (2019). Maya Thomas. In P. A. Ertmer, J. Quinn, & K. Glazewski (Eds.) *The ID casebook: Case studies in instructional design* (5<sup>th</sup> ed.) (pp. 57-63). New York: Routledge.
- Santavicca, N., Bazzul, J., & Witzig, S. (2019). Camping science education: A trip to camp Wilde and the queer nature of nature. In W. Letts & S. Fifield (Eds.), *STEM of desire: Queer theories in science education* (pp. 289-305). Leiden, Netherlands: Brill - Sense Publishers
- Tippins, D. J., Haverkos, K., Kutner, M., Kayumova, S., & Britton, S. (2019). STEM Education and the Theft of Futures of Our Youth: Some Questions and Challenges for Educators. In *Converting STEM into STEAM Programs* (pp. 285-305). Springer, Cham.
- Weiland, T., Orrill, C. H., Brown, R. E., & Nagar, G. G. (2019, online). Mathematics teachers' ability to identify situations appropriate for proportional reasoning. *Research in Mathematics Education*, xx(xx), xx-xx. doi: 10.1080/14794802.2019.1579668
- Williams-Pierce, C., Plaxco, D., Reimer, P. N., Simpson, A., Orrill, C. H., Burke, J. P., Sinclair, N., Guyevskey, V., Ellis, A. B., & Dogan, M. F. (2019). Mathematical play: Across ages, context, and content. In S. Otten, A. G. Candela, Z. de Araujo, C. Haines, & C. Munter (Eds.), *Proceedings of the forty-first annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1979-1990). St Louis, MO: University of Missouri.

## 2020

- Brown, R. E., Epstein, M. L., & Orrill, C. H. (2020). When constant in a proportional relationship isn't constant – A sign of not-so-shared understanding. *Investigations in Mathematics Learning*, 12(3), 194-207. <https://doi.org/10.1080/19477503.2020.1772035>
- Brown, R. E., Orrill, C. H., & Park, J. (2020). Differences in knowledge used by practicing teachers in a dynamic versus static proportional task. *Mathematics Education Research Journal*. <https://doi.org/10.1007/s13394-020-00350-x>
- Brown, R. E., Weiland, T., & Orrill, C. H. (2020). Mathematics teachers' use of knowledge resources when identifying proportional situations. *International Journal of Science and Mathematics Education*, 18, 1085-1104. <https://doi.org/10.1007/s10763-019-10006-3>
- Godwin, A., Cribbs, J. & Kayumova, (2020). Perspectives of Identity as an Analytic Framework in STEM Education in Johnson, C. C., Mohr-Schroeder, M. J., Moore, T. J., & English, L. D. (Eds.). (2020). *Handbook of Research on STEM Education*. Routledge.
- Kayumova, S. & Harper, A. (2020). Toward onto-epistemic Justice: Making Identities and Agencies of Bilingual/Multilingual learners Visible in Science Education. Paper accepted at the *International Conference of Learning Sciences*. Nashville, TN.

Orrill, C. H., Copur-Gencturk, Y., Cohen, A., & Templin, J. (2020). Revisiting purpose and conceptualization in the design of assessments for teachers of mathematics. *Research in Mathematics Education*, 22(2), 209-224. <https://doi.org/10.1080/14794802.2019.1702893>.

Weiland, T., Orrill, C. H., Nagar, G. G., Brown, R. E., & Burke, J. (2020). Framing a robust understanding of proportional reasoning for teachers. *Journal of Mathematics Teacher Education*, 24, 179-202. <http://doi.org/10.1007/s10857-019-09453-0>.

## 2021

Brown, R. E., & Orrill, C. H., (2021, October). Using proportional tasks to explore teachers' ability to make sense of student thinking. In Olanoff, D., Johnson, K., & Spitzer, S. (Eds), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 419-426). Philadelphia.

Güçler, B. (2021). High school teachers' development of thinking about the limit concept. In Olanoff, D., Johnson, K., & Spitzer, S. M. (Eds.), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, pp. 707-711. Philadelphia, PA.

Kayumova, S. & Buxton, C. (2021): Teacher subjectivities and multiplicities of enactment: Agential realism and the case of science teacher learning and practice with multilingual Latinx students. *Journal of Professional Development in Education*. DOI: 10.1080/19415257.2021.1879225

Kayumova, S. & Tippins, D. (2021). The quest for sustainable futures: Designing transformative learning spaces with Black, Brown, and Latinx young people through critical response-ability. *Cultural Studies of Science Education*. DOI: 10.1007/s11422-021-10030-2

Nagar, G. G., Hegedus, S., & Orrill, C. H. (2021, October). A framework for analysis of variance and invariance in a dynamic geometry environment. In Olanoff, D., Johnson, K., & Spitzer, S. (Eds), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1749-1753). Philadelphia, PA.

Orrill, C. H., & Brown, R. E. (2021, October). Teachers' knowledge resources for solving proportions. In Olanoff, D., Johnson, K., & Spitzer, S. (Eds), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 461-465). Philadelphia, PA.

Orrill, C. H., Epstein, M., Wang, K., Malik, H., & Copur-Gencturk, Y. (2021, October). Designing assessment items for measuring PCK for proportional reasoning. In Olanoff, D., Johnson, K., & Spitzer, S. (Eds), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 492-493). Philadelphia, PA.

Orrill, C. H., & Millett, J. (2021). Teachers' abilities to make sense of variable parts reasoning. *Mathematical Thinking and Learning*, 23(3), 254-270. <https://doi.org/10.1080/10986065.2020.1795567>

Stroup, W & A. Petrosino (2021). Establishing statistical significance at scale for pattern-based items. Virtual poster and paper presented at the American Education Research Association Annual Meeting. Scheduled for Orlando, FL but held virtually.

Weiland, T., Orrill, C. H., Nagar, G. G., Brown, R. E., & Burke, J. (2021). Framing a robust understanding of proportional reasoning for teachers. *Journal of Mathematics Teacher Education*, 24, 179-202. <https://doi.org/10.1007/s10857-019-09453-0>

## 2022

- Cieto, M. M., & Witzig, S. B. (2022). It starts at home: Building upon students' extracurricular interests and STEM knowledge in the classrooms through socio- scientific issues-based approaches. *Science and Children*, 59(5), 38-42.
- Epstein, M. L., Malik, H., Wang, K., & Orrill, C. H. (2022). Teacher-responses: Highlight characteristics of low response process validity for item(s) measure teachers' pedagogical content knowledge. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 671-675). Middle Tennessee State University.
- Güçler, B. & Ji, C. (2022). What do the emerging themes in high school teachers' journals tell us about their thinking? In Lischka, A. E., Dyer, E. B., Jones, R. S., Lovett, J. N., Strayer, J., & Drown, S. (Eds.), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, pp. 1394-1402. Nashville, TN: Middle Tennessee State University. (80%)
- Harper, A. & Kayumova, S. (2022). Invisible multilingual Black and Brown girls: Raciolinguistic narratives of identity in science education. *Journal of Research in Science Teaching*. DOI: <https://doi: 10.1002/tea.21826>.
- Kayumova, S., Arrigo, A. F., Harper, A., Richard, E., & Welty, H. (2022). *Supporting STEM identity development through asset-based positioning*. Rapid Community Report Series. Digital Promise; International Society of the Learning Sciences. URI.
- Kayumova, S. & Dou, R. (2022). Equity and justice in science education: Toward a pluriverse of multiple identities and onto-epistemologies. *Science Education*, 106(5), 1097-1117. <https://doi.org/10.1002/sce.21750>.
- Kayumova, S., & Sengupta, P. (2022). Beyond representationalism: Heterogeneity as an ethical turn in STEM and computing education. In *The learning sciences in conversation* (pp. 218-234). Routledge.
- Liu, Z., Gearty, Z., Richard, R., Orrill, H. C., Kayumova, S., Balasubramanian, R. (2022). Computational thinking into K-12 classrooms: Experiences and challenges from professional learning experiences. In C. Chinn, E. Tan, C. Chan & Y. Kali (Eds.), *Proceedings of the 16th International Conference of the Learning Sciences - ICLS 2022* (pp. 2100-2101). International Society of the Learning Sciences. <https://2022.isls.org/proceedings/>
- Nagar, G. G., Hegedus, S., & Orrill, C. H. (2022). High school teachers' discernment of invariant properties in a dynamic geometry environment. *Educational Studies in Mathematics*, 111(1), 127-145. <https://doi.org/10.1007/s10649-022-10144-6>
- Nagar, G.G., Hegedus, S., & Orrill, C. H. (2022). Teachers' understanding of draggable geometric objects: Variance and invariance in a dynamic geometry environment. *Digital Experiences in Mathematics Education*, 8(3), 259-286.
- Orrill, C. H., & Brown, R. E. (2022). Mathematics teachers' knowledge for teaching proportion: Using two frameworks to understand knowledge in action. In C. Damşa, & A. Barany (Eds.), *Advances*

*in quantitative ethnography. ICQE 2022.* (pp. 239-253). Springer. [https://doi.org/10.1007/978-3-031-31726-2\\_17](https://doi.org/10.1007/978-3-031-31726-2_17)

- Orrill, C. H., Brown, R. E., Thapa, R., & Nti-Asante, E. (2022). One teacher's knowledge of proportions in practice. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 684-688). Middle Tennessee State University.
- Orrill, C. H., Brown, R. E., Thapa, R., & Nti-Asante, E. (2022). Adapting the knowledge quartet for non-didactic classrooms. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 743-744). Middle Tennessee State University.
- Richard, E., & Kayumova, S. (2022). Examining Early Elementary Computer Science Identity Repertoires within a Curriculum: Implications for Epistemologically Pluralistic Identities. *Journal of Computer Science Integration*, 1(1): X, pp. 1–14. DOI: <https://doi.org/10.26716/jcsi.2022.X.X.36>.
- Takeuchi, M. A., Kayumova, S., de Araujo, Z., & Madkins, T. C. (2022). Going beyond #RetireELL: A call for anti-colonial approaches to languages in STEM education. *Journal of Research in Science Teaching*, 1–4. <https://doi.org/10.1002/tea.21764>
- Waight, N., Kayumova, S., Tripp, J., & Achilova, F. (2022). Towards equitable, social justice criticality: Re-constructing the “Black” box and making it transparent for the future of science and technology in science education. *Science & Education*, 1-23. <https://doi.org/10.1007/s11191-022-00328-0>.

## 2023 & In Press

- Adams, J., Rahm, J., Kayumova, S., & Brandt, C. (2023). Introduction Unpacking “Signs of Learning” in Complex Sociopolitical Environments. *Mind, Culture, and Activity*. DOI: 10.1080/10749039.2023.2185258
- Epstein, M. L., Malik, H., Wang, K., & Orrill, C. H. (accepted). Unpacking response process issues encountered when developing a mathematics teachers' pedagogical content knowledge. *Investigations in Mathematics Learning*.
- Kayumova, S., & Harper, A. (2023). Centering Critical Youth Research Methodologies of Praxis and Care in Post-Pandemic Times: From Respectful Relations and Dialogue towards New Imaginaries. *International Conference of the Learning Sciences (ICLS) 2023*, Montreal, Canada.
- Kayumova, S., & Kahveci, E. (2023). Joint sensemaking among multilingual youth: A case from a science classroom. *International Conference of the Learning Sciences (ICLS) 2023*, Montreal, Canada.
- Kayumova, S., & Strom, K. (2023). Ontology, epistemology, and critical theory in STEM education. In *Oxford Research Encyclopedia of Education*. DOI: <https://doi.org/10.1093/acrefore/9780190264093.013.1508>
- Orrill, C. H., & Brown, R. E. (2023). Using design-based research to develop a professional development model. In J. M. Spector, B. B. Lockee, & M. D. Childress (Eds.), *Learning, design, and technology: An international compendium of theory, research, practice, and policy*. Springer. [https://doi.org/10.1007/978-3-319-17727-4\\_177-1](https://doi.org/10.1007/978-3-319-17727-4_177-1)



Orrill, C. H., Gearty, Z., & Wang, K. (in press). Continuing evolution of research on teaching & learning: Exploring emerging methods for unpacking research on teachers, teaching, and learning. In A. Manizade, N. Buchholtz, & K. Beswick (Eds.), *The evolution of research on teaching mathematics: International perspectives in the digital era*. Springer.

**APPENDIX A**  
**ADVISORY BOARD**

### **ADVISORY BOARD**

The Center has an international and interdisciplinary advisory board, which consists of the following members:

- Allan Cohen – University of Georgia, USA
- Andrew Izsák – Tufts University, USA
- Bharath Sriraman – University of Montana, USA
- Christof Weber – University of Teacher Education, Lucerne, Switzerland
- Christopher Hoadley – University at Buffalo, USA
- David Kirshner – Louisiana State University, USA
- David Williamson Shaffer – University of Wisconsin, USA
- Demetra Pitta-Pantazi – University of Cyprus, Greece
- Eric Hamilton – Pepperdine University, USA
- Joanne Lobato – San Diego State University, USA
- Jeremy Roschelle – Digital Promise, USA
- Jonathan Templin – University of Iowa, USA
- Luis Morena-Armella – National Polytechnic Institute, Mexico
- Lyn English – Queensland University of Technology, Australia
- Maria Blanton – TERC, USA
- Philip Vahey – Houghton-Mifflin Harcourt, USA
- Pratim Sengupta – University of Calgary, Canada
- Tânia Maria Mendonça Campos – Universidade Bandeirante de São Paulo, Brazil
- Todd Campbell – University of Connecticut, USA

## **APPENDIX B**

### **SYMPOSIUM & COLLOQUIUM SERIES (Spring 2023)**

*All Virtual & Available on the Kaput Center YouTube channel  
<https://www.youtube.com/@kaputcenterforresearchandi9240>*



## **Holistic Individualized Coaching: Advancing the Professional Wellbeing of Elementary Mathematics Teachers**

**Dionne Cross Francis, Joseph R. Neikirk Term Professor, Coordinator, CCTE Program**

**University of North Carolina at Chapel Hill, School of Education**

Friday, February 24<sup>th</sup>, 2023

4:00-6:00pm via Zoom



**Abstract:** There is broad consensus that high-quality professional development involves a focus on content and how students’ learn content; in-depth, active learning; fostering coherence across instructional activities and responsibilities; job-embedded; extended duration; and, collective participation. Since Garet et al., (2001)’s seminal study, teacher educators and researchers have continued to design teacher development approaches that align with these components. One type of professional development that aligns closely with these criteria and has demonstrated success in improving teacher quality is instructional coaching. However, despite the widespread integration of coaching into schools, the wellbeing of teachers and students appear to be on the decline. In particular, there are chronic shortages of teachers nationwide with approximately 8% of teachers leaving annually; about 60% of teachers reporting frequent job-related stress; and, an unprecedented decline in mathematics achievement on national standardized tests (NAEP). Although some existing coaching models are effective in improving instructional quality, they tend to focus primarily on advancing teacher content knowledge and instructional skills while overlooking the psychological and affective aspects of teaching which are at the core of wellbeing. This session will focus on presenting a model of mathematics professional development that foregrounds teachers’ professional wellbeing. I will discuss how attending to teachers’ cognition and affect holistically influences their psycho-social-emotional development, mathematics instructional practices, and student outcomes.

**Bio:** Dionne Cross Francis is the Joseph R. Neikirk Term Professor in the Culture, Curriculum and Teacher Education Program at the University of North Carolina at Chapel Hill. Her research focuses on understanding the contextual, cultural, and teacher-specific factors that motivate teacher planning and instruction with the goal of determining the optimal design features of PD that allow teachers to thrive. Results of this work have informed the design and implementation of PD initiatives nationally (Indiana, Georgia) and internationally [Jamaica, Turkey, Kosovo, South Sudan, Ghana (upcoming)]. Dr. Cross Francis has been awarded the national K-12 Promotion of Education award for promoting STEM education from the 2014 Women of Color STEM Conference, the Oak Ridge Associated Universities’ Junior Faculty Enhancement Award, the APA Division 15 Early Career Award and the University of

Georgia's Young Alumni Award. The IU School of Education also awarded her the Students' Choice for Excellence in Teaching award, the Graduate Student Mentoring award and the Trustee's Teaching Award for her work with pre-service teachers and graduate students. She is a co-editor and co-author of two books, *Research on Teacher Identity: Mapping Challenges and Innovations* (2018) and *Teachers' Goals, Beliefs, Emotions, and Identity Development: Investigating Complexities in the Profession* (in press). Her work has been featured in top journals in the field, including *Journal of Mathematical Behavior*, *Journal of Mathematics Teacher Education*, *Teachers College Record*, *Educational Studies in Mathematics*, and *Teaching and Teacher Education*.



## Computational Thinking 2.0: Directions for the Future of Computing Education

**Yasmin Kafai, Lori and Michael Milken President’s Distinguished Professor  
Teaching, Learning, and Leadership Division, University of Pennsylvania Graduate School  
of Education**

Friday, March 24<sup>th</sup>, 2023  
4:00-6:00pm via Zoom

**Abstract:** Over the last decade, initiatives around the world have introduced computing into K-12 education under the umbrella of computational thinking defined by Jeanette Wing (2006) as “involving solving problems, designing systems and understanding human behavior that draws on concepts fundamental to computing.” We need to recognize that code is not neutral, computing technologies reflect the values and biases of their creators and computing alone is not the solution to all problems, it often perpetuates existing concerns, causes new problems or deepens existing ones. Yet, in most classrooms, computing is commonly introduced and experienced as a value-neutral tool without considering its societal and ethical challenges. An expanded framing of computational thinking will include pragmatic, sociocultural, and political dimensions in order to address critical aspects of inequities caused or exacerbated by the societal impact of computing. In my talk, I will present examples of how we can reevaluate and reframe computational thinking to promote the creative and critical transformation of understanding, coding and participating in the world.



**Bio:** Yasmin B. Kafai is Lori and Michael Milken President’s Distinguished Professor at the Graduate School of Education, University of Pennsylvania, with a courtesy appointment in Computer and Information Science. She is a learning designer and researcher of online tools, projects and communities to promote coding, criticality, crafting and creativity. With colleagues at MIT, she developed the programming language Scratch and researched participation in clubs, classrooms, and online communities. More recently, she has investigated the use of electronic textiles to introduce computing, engineering, and crafting to high school students and teachers as part of the nationwide Exploring Computer Science curriculum. She has written several books, among them “Connected Code: Why Children Need to Learn Programming,” “Connected Gaming: What Making Videogames Can Teach Us About Learning and Literacy,” and recently edited with N. Holbert and M. Berland “Designing Constructionist Futures: The Art, Theory, and Practice of Learning Designs” — all published by MIT Press. Kafai earned a doctorate in education from Harvard University while working at the MIT Media Lab. She is a Fellow of the American Educational Research Association and the International Society for the Learning Sciences.



## **I Realized I Had No Idea What Statistics Was or How to Teach It Well: A Journey From School Classroom to Academia**

**Travis Weiland, Assistant Professor, Curriculum & Instruction  
University of Houston's College of Education**

Friday, March 31<sup>st</sup>, 2023  
4:00-5:00pm via Zoom



**Abstract:** In this talk, I will discuss my journey from being a high school mathematics teacher to an assistant professor at a research-intensive university and some of the important things I learned along the way. As part of discussing my journey I will discuss how I was first motivated to explore issues in statistics education and how my research trajectory evolved during my doctoral program into the grant funded work I do now. Part of that evolution came from the opportunities I was able to take advantage of as a doctoral student that I will highlight. I will also discuss what I have learned from more interviews than I like to count about the academic job market, interviewing, the negotiation process, partner hires, elitist hiring practices, and more, as well as self-care strategies I used to make it through what is a long arduous process.

**Bio:** My career in education began with teaching high school mathematics in the mountains of Western North Carolina. During that time, I began working on a master's degree, which I ended up taking graduate courses in statistics for. I had never taken a course in statistics for my undergraduate course work despite being a mathematics major, yet I had been teaching statistics concepts for years to students. Taking those courses made me realize not only how little I understood statistics, but that I had been doing a terrible job of teaching those concepts to students for years. It was this realization that motivated me to pursue a PhD in Mathematics Education to investigate the question of how can we improve the statistical education of students in schools.

All my work stems from two main principles: that education is transformative, and the goal of public education is for democratic equality. More specifically, my research is focused on issues of equity, including the consideration of issues of access, achievement, identity and power, at their intersection with statistics and data science education. I view teacher education as one of the primary levers for transforming the learning experiences of students, which is why much of my work involves transformative research in pre-service teacher education and in the continued education of practicing teachers. I take a design approach in my research to investigate how to co-construct learning environments with teachers to learn statistics through investigating sociopolitical issues and to translate such learning experiences into their mathematics classrooms. I frame my work through a critical statistical literacy lens drawing from the critical literacy work of Paulo Freire to consider how to support teachers and students in reading and writing the word and the world with statistics. To achieve the goal of a critically data literate citizenry, I partner with teachers, school districts, curriculum specialists, and experts across disciplines and fields with a focus on systemic transformation.

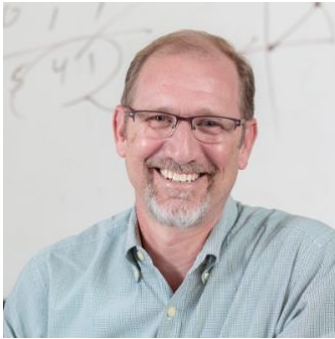




## Quantitative Ethnography: Human Science in the Age of Big Data

David Williamson Schaffer, Area Chair & Professor  
Educational Psychology, University of Wisconsin-Madison School of Education

Wednesday, April 5<sup>th</sup>, 2023  
4:00-6:00pm via Zoom



**Abstract:** In this talk, David Williamson Schaffer looks at the transformation of the social sciences in the age of Big Data through the lens of Quantitative Ethnography, an approach to analyzing human behavior that integrates data-mining, discourse analysis, social interactionism, cognition, learning science, statistics, and ethnography to produce new and innovative ways of thinking that go beyond the old dichotomy of qualitative and quantitative methods and past simple mixtures of methods in thinking about data and data analysis.

**Bio:** David Williamson Schaffer is the Sears Bascom Professor of Learning Analytics and the Vilas Distinguished Achievement Professor of Learning Sciences at the University of Wisconsin-Madison and a Data Philosopher at the Wisconsin Center for Education Research. Before coming to the University of Wisconsin, Professor Schaffer taught grades 4-12 in the United States and abroad, including two years working with the US Peace Corps in Nepal. His M.S. and Ph.D. are from the Media Laboratory at the Massachusetts Institute of Technology. Professor Schaffer taught in the Technology and Education Program at the Harvard Graduate School of Education, and was a 2008-2009 European Union Marie Curie Fellow. His current focus is on merging statistical and qualitative methods to construct fair models of complex and collaborative human activity. Professor Schaffer has led the development of a suite of quantitative ethnographic tools that are being used by more than a thousand researchers in 20 countries as part of the annual International Conference on Quantitative Ethnography. He has authored more than 250 publications with over 100 co-authors, including *How Computer Games Help Children Learn* and *Quantitative Ethnography*.

# **APPENDIX C**

## **STEMester in Review Newsletters**

# STEMester in Review

## Kaput Center Newsletter

### Welcome

Welcome to our wrap-up newsletter focused on Fall 2022. Fall was a lot of fun. We held our first STEM4Girls since the pandemic and welcomed new Executive Board members. We also have some new grant-funding!

As always, you can email us at [kaputcenter@umassd.edu](mailto:kaputcenter@umassd.edu) or check us out at our website <http://kaputcenter.org>. We also have Facebook and Twitter accounts: <http://facebook.com/kaputcenter> and <https://twitter.com/kaputcenter>



## New 3-year NSF Award: Connecting Undergraduates to Biodiversity Instruction through Citizen Science (CUBICS)

**Stephen B. Witzig, Ph.D. (Principal Investigator, PI)**, Associate Professor of STEM Education & Teacher Development and Research Associate at the Kaput Center for Research & Innovation in STEM Education (UMassD), along with **Kathryn Kavanagh, Ph.D. (Co-PI)**, Associate Professor of Biology (UMassD), and **Robert Gegear, Ph.D. (Co-PI)**, Assistant Professor of Biology (UMassD) were awarded a new three-year National Science Foundation (NSF) grant in the amount of \$599,926 titled *Connecting Undergraduates to Biodiversity Instruction through Citizen Science* (CUBICS). The grant includes support for two graduate research assistants, includes The Lloyd Center for the Environment (LCE) as an informal environmental education partner, and includes science faculty from Massasoit Community College, Massachusetts Maritime Academy, and Bridgewater State University as recruiting partners.

The CUBICS project aims to serve the national interest by establishing teaching practices that support active engagement with real-world scientific research to increase student retention in the sciences. Community participation in formal scientific research, or citizen science, has tremendous potential to be a transformative social innovation for undergraduate science education and learning. Students engaged with citizen science projects are active partners in

their learning, providing them with a deeper understanding of the importance of science to the community and increasing the likelihood that they will maintain a career path in the sciences. One major obstacle to bringing citizen science-related curriculum to undergraduates is that faculty lack the educational training needed to translate their scientific expertise into classroom activities that fully engage students. This work will remove this obstacle by creating a community of faculty among diverse institutions in the South Coast region of Massachusetts that will work together to develop citizen science projects through a socioscientific issues-based instructional approach, monitor how they execute their projects, and assess the impacts on their students. Using citizen science projects related to biodiversity and climate change, this project will test a model for how to shift faculty participants from traditional lecture to active involvement of students in real-world data collection and analysis, resulting in the development of a blueprint for expanding citizen science-based undergraduate curriculum to other regions of the country and to other scientific subject areas. Thus, in addition to making a quantum leap in improving retention in undergraduate science at a regional scale, this project's novel educational approach will make a significant contribution to scientific research efforts aimed at conserving and restoring native biodiversity threatened by human-induced environmental change.

**The CUBICS project has the following three aims for our research:**

- AIM 1.** Engage college science faculty in CUBICS professional development program centered on a socioscientific issues-based instructional framework to incorporate and develop citizen science projects for their students.
- AIM 2.** Develop faculty content expertise and commitment to include biodiversity and climate change as a central theme of instruction.
- AIM 3.** Support faculty to transform their practice to increase student engagement and retention in science.

Research has shown that teaching innovations that involve active participation in real-world science exploration improves undergraduate student attitudes, achievement, and retention. Yet, most science faculty, while content experts in their discipline, often lack pedagogical training needed to translate their scientific expertise into curriculum that fully engages their students. The goal of this project is to provide this type of support for college science faculty through the incorporation of community-based or 'citizen' science into their undergraduate classrooms. The means to accomplish this goal will be a series of professional development workshops (Summer Institutes) where faculty from the South Coast region of Massachusetts will gather to learn how to create, contribute to, and maintain biodiversity- and climate-focused citizen science projects in their undergraduate courses. This project will be thoroughly documented by a research plan that investigates the transformational nature of the project through a mixed methods design. It includes rigorous assessment and an experienced advisory board. Educational data collected in this project will be used to elucidate the best methods to develop socioscientific issues-based citizen science projects and demonstrate a means to improve retention in science. The projects will be coordinated and supported by the PI team through the Kaput Center for Research & Innovation in STEM Education which has the infrastructure and expertise needed for widespread coordination and dissemination to connect the public with scientists.

*The NSF IUSE: EDU Program supports research and development projects to improve the effectiveness of STEM education for all students. Through the Engaged Student Learning track, the program supports the creation, exploration, and implementation of promising practices and tools. This is a Level 2, Engaged Student Learning, Improving Undergraduate STEM Education (IUSE) project.*

For questions, or to become involved in the project, contact Stephen Witzig at [switzig@umassd.edu](mailto:switzig@umassd.edu)

## STEM4Girls

**By Kym Welty, Kaput Center Grants Support Specialist**



On Saturday, October 1, 2022, the Kaput Center for Research & Innovation in STEM Education held its 10<sup>th</sup> annual community outreach event called "STEM4Girls Day" at the University of Massachusetts Dartmouth, which was the first time it had been hosted since the pandemic. This free event was open to all girls in grades 3-8 who want to learn more about and engage in Science, Technology, Engineering and Mathematics (STEM). This year, nearly 200 girls registered and just under 100 girls attended from the SouthCoast area, including students from Our Sister School and Global Learning Charter School in New Bedford, Fall River Public Schools, Atlantis and Argosy Collegiate Charter Schools in Fall River, as well as

several girls from a local Girl Scout troop. Another first: our keynote speaker was introduced by an alumnae of STEM4Girls who is now a UMassD student!

This year's keynote speaker was Megan Winton. Megan currently works as a Great White Shark researcher at the Atlantic Great White Shark Conservancy. She is also a current UMassD School of Marine Science & Technology (SMAST) Ph.D. student. She shared her journey to becoming a researcher with the girls, using many Harry Potter analogies paired with incredible photos from her work with Great White sharks. The keynote



address was followed by a STEM skit performed by students from Our Sisters School in New Bedford. The girls then attended two STEM workshops each, followed by lunch at the new cafeteria, The Grove, along with STEM demonstrations including Photon robots, Ozobots, and Norbert, an Eastern Box turtle from the Lloyd Center for the Environment. The day was capped off with a rousing performance from STEAM the Streets.

We hosted 15 STEM workshops, led by experts who volunteered their time. Some examples included "Ice Cream Thermodynamics", "Scales in Astronomy", "How do Seals Track their Prey Underwater?" and "Design, Engineer, and Make!: Makey Makey, Bristle Bot Challenge & Digital Bling". Presenters included UMassD faculty and graduate students from the College of Engineering, the College of Arts & Sciences, the School of Nursing, and the STEM Education & Teacher Development department. In addition, workshops were led by faculty from Tufts University, as well as local teachers from Fairhaven, Somerset and Our Sisters School. The success of our STEM4Girls day was made possible by the additional support of over 40



volunteers from UMass Dartmouth faculty, staff and students, as well as others from the local communities who wanted to help.



Chandra Orrill, Director of the Kaput Center for Research and Innovation in STEM Education was quoted as saying "I would love to see these girls go into STEM careers, but more than that, I want them to love STEM."

## Quick Notes:

- The Kaput Center Executive Board is delighted to welcome Robert Gegear, Michael Goodman, and Trina Kershaw as its newest members. All members serve 3 year, renewable terms.
- The Kaput Center is under periodic review. This is a required process for all UMass Centers. We hope to get our report back in the Spring. If you are contacted to complete a survey as one of our stakeholders, PLEASE take a moment to do that for us!
- Save the dates for our upcoming colloquia. All will be live on Zoom from 4:00-6:00pm eastern time. We will also post them on the Kaput Center Youtube channel for later viewing. For more information, watch your inbox or follow us on Facebook.
  - February 24, 2023: Dr. Dionne Cross Francis “Holistic Individualized Coaching: Advancing the Professional Wellbeing of Elementary Mathematics Teachers” (Research Series)
  - March 24, 2023: Dr. Yasemin Kafai “Computational Thinking 2.0: Directions for the Future of Computing Education” (Inaugural talk in the Big Ideas series)
  - March 31, 2023: Dr. Travis Weiland “I Realized I Had No Idea What Statistics Was or How to Teach It Well: A Journey from School Classroom to Academia” (Inaugural talk in the Student to Scholar series)
  - April 5, 2023: Dr. David Williamson Shaffer “Quantitative Ethnography: Human Science in the Age of Big Data” (Big Ideas Series)

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# STEMester in Review

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## Kaput Center Newsletter

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### Welcome

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Email us at [kaputcenter@umassd.edu](mailto:kaputcenter@umassd.edu) or check us out at our website <http://kaputcenter.org>. We also have Facebook and Twitter accounts: <http://facebook.com/kaputcenter> and <https://twitter.com/kaputcenter>



### Holistic Individualized Coaching: Advancing the Professional Wellbeing of Elementary Mathematics Teachers

**By Zarina Gearty, Ph.D., 2023 Graduate of STEM Education**

On February 24<sup>th</sup>, the Kaput Center virtually hosted Dr. Dionne Cross Francis, a Joseph R. Neikirk Professor in the Culture, Curriculum and Teacher Education Program at the University of North Carolina at Chapel Hill. Dr. Cross Francis studies teacher motivation, specifically focusing on understanding the contextual, culture, and teacher-specific factors that allow teachers to thrive. Her work has influenced both national and international professional development initiatives and we were very honored to have her share a bit about her research with us at the Kaput Center.



Dr. Cross Francis's presentation was focused teaching coaching. She started by situating herself, sharing and talking about the biases she has in her research, as well as her assumptions about classrooms and the school as a learning ecology. She explained how she sees teachers as part of a bigger system, drawing on Bronfenbrenner's



ecological systems theory. She often repeated that she views teachers as learners, just as teachers view their students as learners.

Dr. Cross Francis shared several key take-aways from different phases of her research. In one phase where her goal was to understand what constructs inform teachers' decision-making and practice, she talked about how she came to view teachers as individuals with individual differences and variability. Another key take-away was that teaching has psychological, cognitive, affective, social and behavior dimensions that need to be acknowledged. In the second phases of studies, she discussed how her focus was on exploring design features of PD that would support ambitious teaching. Her key finding from this phase was that shifts in teacher knowledge and skill often did not lead to similar shifts in student learning.

All of her research led her to design the Holistic Individualized Coaching (HIC) model. She walked the audience through the six components of the model and pointed out how it differed from other models. She then shared her findings from implementing this model in Georgia, USA and in Ghana, Africa, which were positive in supporting cognitive, behavior, psychological and socio-emotional changes related to math teaching.

To see this talk, visit: <https://www.youtube.com/watch?v=6hY70viC0pk&t=2s>

## Big Ideas: Yasmin Kafai Introduces Computational Thinking 3.0

By Ali Daniyal Asif, Kaput Center Graduate Research Assistant



The Kaput Center for Research and Innovation in STEM Education organized its first step towards a series of colloquiums of big ideas. The goal of the big idea was to have the leaders in STEM education research come and talk about an issue in education research. Dr. Yasmin Kafai, Lori and Michael Milken President's Distinguished Professor at the graduate school of Education at the University of Pennsylvania, was the first speaker of this series. In this insightful talk, Dr. Kafai unfolded the emerging trends in computational thinking (CT), such as CT 2.0 and CT 3.0. As an introduction, she characterized the theory space of CT research on three framings of learning in education research. Among these three framings most prevalent is

cognitive. Cognitive framing mainly targets computational concepts and practices investigating the development of mental models of an individual with little space for personal relevance or

social concerns. Situated framing focuses on personally meaningful contexts within and across communities with less focus on the issues of inclusion and cultural relevance. Critical framing highlights the issues of equity, diversity, and social justice inherent to the power dynamics of every society but foreshadows the computational concepts and practices.

CT 2.0 shifts the tides of traditional rule-driven practices of CT to data-driven models providing new classes of real-world applications for classroom practices. The emerging trend in Artificial Intelligence, such as ChatGPT of OpenAI and Bard from Google, has changed the dynamics of computer science education. This raises substantial implications for including AI tools to harness their power in educational endeavors.

In the end, Dr. Kafai explained her term CT 3.0 as it emphasizes the need to include the public voice in the architecture and design of the digital world to make and keep the digital public space inclusive and livable.

From an audience perspective, I find myself in rhythm with Dr. Kafai's arguments. In many ways, my own research is inspired by Dr. Kafai's work, which challenges me to think about CT in new and innovative ways.

To see Dr. Kafai's presentation, visit this link: <https://www.youtube.com/watch?v=DjBOpJt9bb4>

## Student to Scholar: Travis Weiland

By Chandra Orrill, Kaput Center Director

For several years we have been thinking about how to help connect our alumni to our current students. This year, we created the Student to Scholar Colloquium that is designed to do just that! Our first ever Student to Scholar speaker was Dr. Travis Weiland. Travis finished his degree in 2017. He moved from UMass Dartmouth to a tenure-track position at Appalachian State University. Shortly after, he relocated to the University of Houston.

Travis was kind enough to talk to our students about the transition between being a student and a faculty member, opportunities to participate in while being a student, and different ways to think about a variety of experiences.

Because Travis has changed jobs as his family needs have changed, he also has considerable experience interviewing for positions and learning about new workplace cultures. He was very open and inviting in sharing this information with our current students and others in the audience.



Many students commented on how helpful it was to hear a recent graduate share his advice. And, this was the colloquium that attracted the most students this year! We thank Dr. Weiland for visiting and hope to be able to schedule more colloquia of this kind in the coming years.

To see this talk, visit <https://youtu.be/MqwrjSql16k>

## Big Ideas: David Williamson Shaffer Explains Why We Need Quantitative Ethnography

By Chandra Orrill, Kaput Center Director

We closed out our colloquium series on April 5 with David Williamson Shaffer, the Sears Bascom Professor of Learning Analytics and Vilas Distinguished Achievement Professor of Learning Sciences at the University of Wisconsin-Madison. David introduced the audience to what quantitative ethnography is in a way that tightly connected it to both qualitative and quantitative research. His talk also emphasized the roles of theory in empirical research.

While the talk was intended to introduce quantitative ethnography (which it did), the clarity with which David's slides and his talk linked all of the critical aspects of research ranging from the phases of engaging with data to the required data loss to the use of theory, that it's worth a watch just to see that discussion. In fact, I was able to take the first several minutes of the video to my Ph.D. course the next day to unpack it with my students, who found it extremely useful.



David's talk is available at <https://youtu.be/TX-NeXBE9MA>

### Quick Notes:

- Chandra Orrill departed the University on May 31, 2023. A new director should be appointed very soon.

## The Kaput Center's Published Articles and Proceedings

### 2022

Cieto, M. M., & Witzig, S. B. (2022). It starts at home: Building upon students' extracurricular interests and STEM knowledge in the classrooms through socio- scientific issues-based approaches. *Science and Children*, 59(5), 38-42.

Epstein, M. L., Malik, H., Wang, K., & Orrill, C. H. (2022). Teacher-responses: Highlight characteristics of low response process validity for item(s) measure teachers' pedagogical content knowledge. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 671-675). Middle Tennessee State University.

Güçler, B. & Ji, C. (2022). What do the emerging themes in high school teachers' journals tell us about their thinking? In Lischka, A. E., Dyer, E. B., Jones, R. S., Lovett, J. N., Strayer, J., & Drown, S. (Eds.), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education*, pp. 1394-1402. Nashville, TN: Middle Tennessee State University.

Harper, A &, Kayumova, S. (2022). Invisible multilingual Black and Brown girls: Raciolinguistic narratives of identity in science education. *Journal of Research in Science Teaching*. DOI: <https://doi.org/10.1002/tea.21826>.

Kayumova, S., Arrigo, A. F., Harper, A., Richard, E., & Welty, H. (2022). *Supporting STEM identity development through asset-based positioning*. Rapid Community Report Series. Digital Promise; International Society of the Learning Sciences. URI.

Kayumova, S. & Dou, R. (2022). Equity and justice in science education: Toward a pluriverse of multiple identities and onto-epistemologies. *Science Education*, 106(5), 1097-1117. <https://doi.org/10.1002/sce.21750>.

Kayumova, S., & Sengupta, P. (2022). Beyond representationalism: Heterogeneity as an ethical turn in STEM and computing education. In *The learning sciences in conversation* (pp. 218-234). Routledge.

Liu, Z., Gearty, Z., Richard, R., Orrill, H, C., Kayumova, S., Balasubramanian, R. (2022). Computational thinking into K-12 classrooms: Experiences and challenges from professional learning experiences. In C. Chinn, E. Tan, C. Chan & Y. Kali (Eds.), *Proceedings of the 16<sup>th</sup> International Conference of the Learning Sciences - ICLS 2022* (pp. 2100-2101). International Society of the Learning Sciences. <https://2022.isls.org/proceedings/>

Nagar, G. G., Hegedus, S., & Orrill., C. H. (2022). High school teachers' discernment of invariant properties in a dynamic geometry environment. *Educational Studies in Mathematics*, 111(1), 127-145. <https://doi.org/10.1007/s10649-022-10144-6>

Nagar, G.G., Hegedus, S., & Orrill, C. H. (2022). Teachers' understanding of draggable geometric objects: Variance and invariance in a dynamic geometry environment. *Digital Experiences in Mathematics Education*, 8(3), 259-286.

Orrill, C. H., & Brown, R. E. (2022). Mathematics teachers' knowledge for teaching proportion: Using two frameworks to understand knowledge in action. In C. Damşa, & A. Barany (Eds.), *Advances in quantitative ethnography. ICQE 2022*. (pp. 239-253). Springer. [https://doi.org/10.1007/978-3-031-31726-2\\_17](https://doi.org/10.1007/978-3-031-31726-2_17)

Orrill, C. H., Brown, R. E., Thapa, R., & Nti-Asante, E. (2022). One teacher's knowledge of proportions in practice. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 684-688). Middle Tennessee State University.

Orrill, C. H., Brown, R. E., Thapa, R., & Nti-Asante, E. (2022). Adapting the knowledge quartet for non-didactic classrooms. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44<sup>th</sup> annual meeting of the North American Chapter of the International Group for Psychology in Education* (pp. 743-744). Middle Tennessee State University.

Richard, E., & Kayumova, S. (2022). Examining Early Elementary Computer Science Identity Repertoires within a Curriculum: Implications for Epistemologically Pluralistic Identities. *Journal of Computer Science Integration*, 1(1): X, pp. 1-14. DOI: <https://doi.org/10.26716/jcsi.2022.X.X.36>.

Takeuchi, M. A., Kayumova, S., de Araujo, Z., & Madkins, T. C. (2022). Going beyond #RetireELL: A call for anti-colonial approaches to languages in STEM education. *Journal of Research in Science Teaching*, 1-4. <https://doi.org/10.1002/tea.21764>

Waight, N., Kayumova, S., Tripp, J., & Achilova, F. (2022). Towards equitable, social justice criticality: Re-constructing the "Black" box and making it transparent for the future of science and technology in science education. *Science & Education*, 1-23. <https://doi.org/10.1007/s11191-022-00328-0>.

### 2023 & In Press

Adams, J., Rahm, J., Kayumova, S., & Brandt, C. (2023). Introduction Unpacking "Signs of Learning" in Complex Sociopolitical Environments. *Mind, Culture, and Activity*. DOI: 10.1080/10749039.2023.2185258

Epstein, M. L., Malik, H., Wang, K., & Orrill, C. H. (accepted). Unpacking response process issues encountered when developing a mathematics teachers' pedagogical content knowledge. *Investigations in Mathematics Learning*.

Kayumova, S., & Harper, A. (2023). Centering Critical Youth Research Methodologies of Praxis and Care in Post-Pandemic Times: From Respectful Relations and Dialogue towards New Imaginaries. *International Conference of the Learning Sciences (ICLS) 2023*, Montreal, Canada.

Kayumova, S., & Kahveci, E. (2023). Joint sensemaking among multilingual youth: A case from a science classroom. *International Conference of the Learning Sciences (ICLS) 2023*, Montreal, Canada.

Kayumova, S., & Strom, K. (2023). Ontology, epistemology, and critical theory in STEM education. In *Oxford Research Encyclopedia of Education*.

DOI: <https://doi.org/10.1093/acrefore/9780190264093.013.1508>

Orrill, C. H., & Brown, R. E. (2023). Using design-based research to develop a professional development model. In J. M. Spector, B. B. Lockee, & M. D. Childress (Eds.), *Learning, design, and technology: An international compendium of theory, research, practice, and policy*. Springer. [https://doi.org/10.1007/978-3-319-17727-4\\_177-1](https://doi.org/10.1007/978-3-319-17727-4_177-1)

Orrill, C. H., Gearty, Z., & Wang, K. (in press). Continuing evolution of research on teaching & learning: Exploring emerging methods for unpacking research on teachers, teaching, and learning. In A. Manizade, N. Buchholtz, & K. Beswick (Eds.), *The evolution of research on teaching mathematics: International perspectives in the digital era*. Springer.

## Congratulations to Our Ph.D. Graduates



Pictured (starting bottom left and going counter-clockwise): Rob Nanna '23, Jinsook Park '23, Chandra Orrill, Shakhnoza Kayumova, Zarina Gearty '23, Marty Epstein '22, and Stephen Witzig.