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Kaput Center for
Research and Innovation in STEM Education

ANNUAL REPORT FY2023-2024

KAPUT CENTER FOR RESEARCH AND INNOVATION
IN STEM EDUCATION
October 18, 2024

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 FY23-24.

A product of Kaput Center for Research and Innovation in STEM Education, University of Massachusetts Dartmouth

https://www.umassd.edu/kaput-center/

The information and analysis in this report does not represent an official statement of view of the University of Massachusetts.

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.

Shakhnoza Kayumova, Ph.D. – Director, Kym Welty – Grants Support Specialist

EXECUTIVE BOARD FY24

- **Paul Fredette**, MSEE (Board Chair), President & Founder of Promptus Communications, Inc. & Chief Technology Officer of American Doctors Online *(term expires 11/24)*
- **James Burke**, PhD, Engineering/Technology Teacher at Somerset-Berkley Regional High School *(term expires 5/25)*
- **Karen Chang**, PhD, Instructor of Chemistry at Naval Academy Preparatory School *(term expires 3/25)*
- **Marylou T. Clarke**, CAGS, Assistant Superintendent, Dartmouth Public Schools (Retired) *(term expires 5/25)*
- **Elizabeth Cullen**, BA, Director/Co-Founder of Rhode Island STEAM Academy *(term expires 11/24)*
- **Robert Gegear**, PhD, Associate Professor of Biology at UMass Dartmouth *(term expires 9/25)*
- **Michael Goodman**, PhD, Sr. Advisor to the Chancellor for Economic Development & Strategic Initiatives at UMass Dartmouth *(term expires 9/25)*
- **Beste Gucler**, PhD, Associate Professor of Math Education at UMass Dartmouth *(term expires 10/26)*
- **Trina Kershaw**, PhD, Professor of Psychology at UMass Dartmouth *(term expires 9/25)*
- **Walter Stroup**, PhD, Associate Professor & Chair of Department of Education at UMass Dartmouth *(term expires 10/26)*
- **Jay Wang**, PhD, Professor & Chair of Physics at UMass Dartmouth *(term expires 3/25)*
- **David Welty**, PhD, Supervisor of Curriculum, Instruction, & Assessment at Fairhaven High School *(term expires 5/24)*
- **Stephen Witzig**, PhD, Associate Professor of Science Education & Graduate Program Director, STEM Education PhD at UMass Dartmouth *(term expires 10/24)*

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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 1st, 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 starting July 1, 2023 ending July 31, 2024, which is Fiscal Year 2024. This document was prepared by Dr. Shakhnoza Kayumova, Director of the Center with support from Kimberly Welty, Grant Support Specialist.

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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 14th, 2007 and its was officially established by Dr. Anthony Garro, Provost of the University of Massachusetts Dartmouth, on March 1st, 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 pause 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. An internal search was conducted and Dr. Shakhnoza Kayumova was named the new Kaput Center Director effective June 6, 2023.

This report documents the ongoing work of the Kaput Center through FY2024.

Kaput Center Director's End of Year Report 2023-2024

I am honored to present the Kaput Center's Annual Report for 2023-2024. This year marked a transition in leadership following Dr. Orrill's departure from the university. After an internal search, I was appointed as the Director of the Kaput Center. My initial months were dedicated to gaining a comprehensive understanding of the Center's operations, services, outreach efforts, research opportunities, and ongoing collaborations. This report summarizes our key activities, accomplishments, and future directions.

In my first three months, I prioritized developing a clear understanding of the Center's existing operations and potential areas for growth. I engaged in multiple meetings with board members and university administrators, including Drs. Ram Bala, CAS Dean Robert Jones, Dr. Shannon Jenkins (former Associate Dean of CAS), and Dr. VanderGhayst (former Dean of Engineering). These conversations provided valuable insights into how the Kaput Center collaborates with various units within the university. During this process, I identified several key areas for development. The need for a new website became apparent, along with the necessity to create clear procedures for the Center's operations. In collaboration with the CAS Dean's office, we developed an activities and scope schema to guide future initiatives. This schema was subsequently presented to the Kaput Center's board for feedback and refinement (see page #9 for details).

Additionally, I held discussions with the STEM Education and Teacher Development faculty to emphasize my commitment for a collaboration and collective effort. Graduate students from the PhD program, as well as PhD and MAT faculty, are deeply integrated into the activities of the Kaput Center. The Center can serve as a hub where these programs intersect, facilitating collaboration on research projects, outreach initiatives, and professional development opportunities. This symbiotic relationship can allow graduate students to engage in research and community outreach, while faculty contribute their expertise to help shape the Center's direction and initiatives. This process resulted in two external grant submissions connected to the activities in the MAT program (see the page #14 on grants for more details).

In early Fall, we organized our signature annual event, STEM4Girls. This year's event set a new record with 170 local girls registering, more than doubling the 80 participants from previous years. We were also thrilled to have over 80 adults, volunteers, and 20 workshop attendants contributing to the event. With the help of Board Director Dr. Paul Fredette, we were honored to host Dr. Stephanie Milam, James Webb Space Telescope Deputy Project Scientist for Planetary Science, as our plenary speaker. Dr. Milam shared her inspiring journey as a planetary scientist at NASA's Goddard Space Flight Center, captivating attendees with her work and experiences. Our efforts for STEM4Girls were generously supported by the Jacobs Family Donor Advised Fund of the SouthCoast Community Foundation. This funding was instrumental in enabling us to serve the community and allowed us to expand our reach.

Immediately following the STEM4Girls event, we submitted three major external grants to the National Science Foundation (NSF), totaling approximately $6 million. These grant submissions

reflect the collaborative efforts of our faculty and graduate students, whose research continues to push the boundaries of STEM education innovation.

During the Spring semester, I received the Fulbright Scholar award and was on sabbatical leave, and Dr. Shannon Jenkins assumed the responsibilities of the Director. Despite my sabbatical, I continued to work closely with Kym Welty and our graduate students, particularly in working on grants and providing grant support. One notable accomplishment was a successful response to inquiries from NSF program officers regarding one of our collaborative grants. Our five-page response ultimately secured the grant and will play an important role in Kaput Center's position as a leader in STEM education research.

Additionally, during this period, we were awarded a new grant for the STEM Cyclists program in collaboration with Tufts University and University of Buffalo. The STEM Cyclists research is based on the idea that bikes are an engineering system centered on a transparent technology that promotes freedom of movement and thus has the potential to democratize mobility and access. As an accessible technology it allows for tinkering, redesigning, repairing, customizing, re-mixing, repurposing, building, and re-building. This project uses bikes and biking to introduce STEM content and experiences to traditionally underrepresented youth (grades 9-10) by having them participate in place-based informal learning activities. The project is funded by the Advancing Informal STEM Learning (AISL) program, which supports projects that contribute to research and practice that considers informal STEM learning's role in equity and belonging in STEM and co-funded by the Innovative Technology Experiences for Students and Teachers (ITEST) program, which supports projects that build understandings of practices, program elements, contexts, and processes contributing to increasing students' knowledge and interest in science, technology, engineering, and mathematics (STEM) and information and communication technology (ICT) careers.

As of June 1st, I resumed my full responsibilities as Director. Our team remains committed to advancing the Kaput Center's mission through innovative research, community outreach, and collaborations with faculty and external partners. Looking ahead, we aim to continue building on the momentum of this year's successes, with a focus on securing additional funding, expanding our programs, and fostering new partnerships.

Acknowledgments: I want to extend my sincere gratitude to the Kaput Center's board members, faculty, staff, and volunteers who have contributed to our achievements this year. Special thanks go to Dr. Shannon Jenkins for her leadership during my sabbatical and to Kym Welty and our graduate students for their tireless efforts in grant applications and program development. I look forward to working with all of you in the coming year as we continue to make strides in STEM education and innovation.

Dr. Shakhnoza Kayumova
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.

https://www.umassd.edu/kaput-center/, our website, went live in spring 2024. The previous website address (kaputcenter.org) is no longer in use.

In addition to the devices, the Kaput Center has a large library that supplements the Campus library facility, and which includes 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

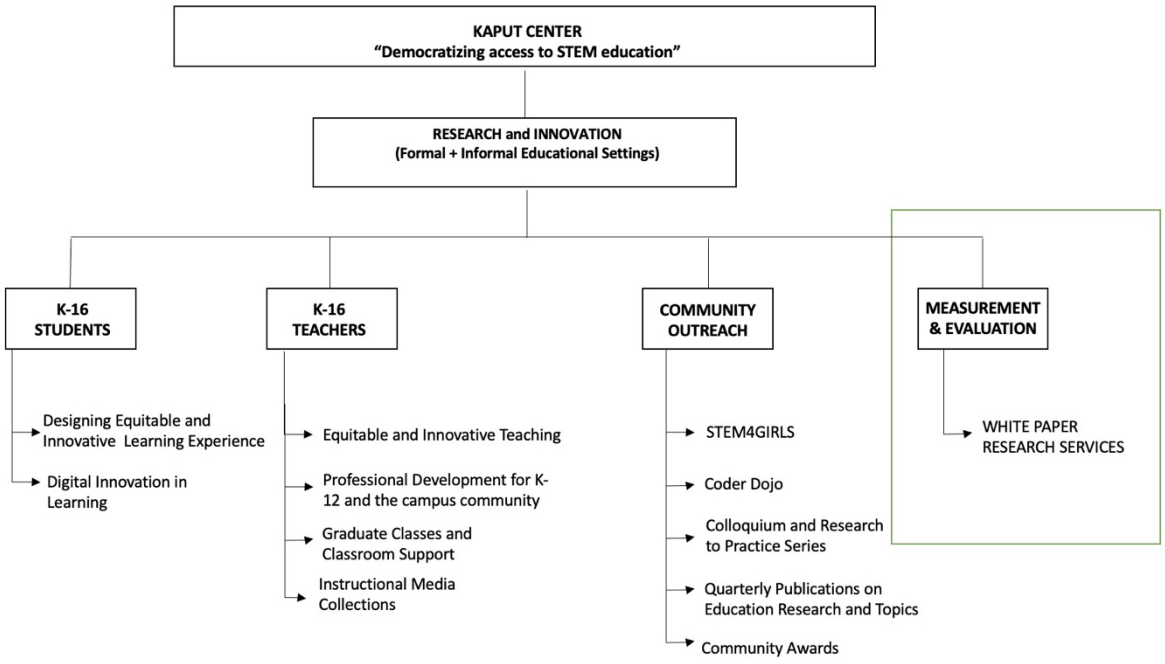

Figure 1. The schema for KC organization that was proposed during the discussions*

This schema outlines the organizational structure and focus areas of the Kaput Center, developed after meetings and discussions with various stakeholders. It is a part of ongoing discussions about the strategic areas where we need to focus and highlight the center's commitment to democratizing access to STEM education through its research and innovation in both formal and informal educational settings. The structure categorizes the center's efforts into three key areas: K-16 Students, K-16 Teachers, and Community Outreach, each addressing specific programs and initiatives designed to foster equitable and innovative learning and teaching experiences.

The Measurement and Evaluation column was proposed as a future endeavor for the center, but at present, KC does not have the capacity to take on such services. Instead, this column would be better represented by the research support we currently provide, including grant pre- and post-award services and general research support for our faculty and collaborators.

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.

Table 2: Revenue & Costs for FY24

Expense Type	Description	Amount
Revenue	University Support (Salaries, Fringe & Operational Budget)	$31,597.00
	Gifts	$350.00
	Indirect Revenue	$28,591.31
	Total Revenue	$60,538.31
Direct Expenses		
Payroll	Total Salaries-Kym W. (including OT)	$ 22,911.82
	Total Fringe	$ 10,600.57
	Total Payroll	**$ 33,512.39**
Non-Payroll		
Office/Admin Supplies	**Total Office & Admin Supplies**	**$280.48**
Facility & Operations	Food & Beverage	$235.49
	Gift Fee	$ 10.50
	Subscriptions	$352.49
	Books	$37.83
	Total Facility & Operations	**$636.31**
Printing Expenses	Copier Expense	$1,383.32
	Total Printing Expenses	**$1,383.32**
Phone Expenses	Telecom Services Voice	$657.10
	Total Telecom Services Voice	**$657.10**
STEM4Girls Expenses		
	Technician Fees	$160.00
	Entertainment	$1,500.00
	Clothing	$3,630.43
	Workshop Materials	$1,230.15
	Food & Beverage	$3,886.04
	Non-Employee Expenses	$893.39
	Advertising	$70.95
	Total STEM4Girls	**$11,370.96**

	Total non-payroll	**$14,328.17**
	Total Direct Expenses	**$47,840.56**

Financial Outlook for FY23-24 and Planning for FY24-25

During the FY 2023-2024, the Kaput Center received the same amount of university support towards operational costs as in previous years. This funding has been critical in maintaining our key activities, including outreach programs, staff support, and research support.

However, as we look ahead to the fiscal year 2024-2025, there have been significant cuts. The reduction in funding poses challenges to our operations, particularly for high-impact events like STEM4Girls, which are critical to our mission but also expensive to host. The external funding support that we received for the event also ends as of FY 24-25. In light of the upcoming budgetary constraints, securing dedicated funding for such events will be critical to avoid depleting our general operational funds.

Indirect revenue currently forms a significant portion of our overall income. However, it is closely tied to our success in securing external grants. If university support continues to decrease or if indirect revenue fluctuates due to irregular grant funding, the Center could face operational challenges that might compromise our ability to maintain ongoing programs and initiatives.

To ensure the sustainability and growth of the Kaput Center, we may need to think about alternative revenue streams. This could include seeking corporate sponsorships, introducing program fees for certain initiatives, and enhancing our fundraising efforts. These steps can provide the financial stability, while ensuring that the Center remains resilient in the face of funding uncertainties.

As Director, I am committed to exploring these options to secure the financial future of the Kaput Center and to continuing our important work in democratizing STEM education access for all.

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 2024 with 4 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.

Computational Thinking Counts in Elementary Grades: Powerful STEM Teaching and Learning for the 21st 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.

Connecting Undergraduates to Biodiversity Instruction through Citizen Science (CUBICS). Stephen Witzig (PI), Robert Gegear, 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.

STEMcyclists: Black and Brown Youth Transforming STEM via Bikes. Shakhnoza Kayumova (PI) working with University of Buffalo and Tufts University received this NSF grant focused on

using bikes and biking to introduce STEM content and experiences to traditionally underrepresented youth (grades 9-10) by having them participate in place-based informal learning activities. The researchers along with community organizations work together to plan and facilitate a summer institute and cohort sessions during the academic year. The youth will engage in STEM learning in their community by creating and contributing knowledge that informs their own learning in topics like science, engineering, and biomechanics.

Symposium & Colloquium Series

During FY 23-24, we revisited the Symposium & Colloquium Series as part of our mission to address fundamental problems in science, mathematics, engineering, and computer science education. These series are essential for fostering interdisciplinary discussions and research collaborations. After careful review, we have decided to update and expand this initiative by launching a Research-to-Practice Series in FY 24-25, which will complement ongoing research symposiums and provide a platform for translating cutting-edge research into practical applications for educators, policymakers, and community stakeholders.

All of the Colloquium talks and Research to Practice series will be available on the Kaput Center YouTube channel and are accessible through the Kaput Center Website.

Supporting the PhD Program

The Kaput Center for STEM Education Research and Innovation serves not only as an intellectual hub for research and innovation but also as a physical space where various research meetings with graduate students and faculty are conducted. Supporting both research groups and PhD students, the Center provides a collaborative environment for fostering critical discussions and innovative ideas.

During FY 23-24, the Center expanded its role as a key meeting space for the university's research community. Notably, Dr. Walter Stroup initiated a weekly Friday Research, Thinking, and Innovation Informal Meeting Series, which brings together graduate students and faculty for discussions on ongoing research. This initiative has transformed the Center into a hub for conversations, convenings, and in-depth research discussions.

The Kaput Center continues to play a vital role in supporting the PhD program within the Department of STEM Education and Teacher Development. Since the launch of the STEM Education PhD program in Fall 2018, the Kaput Center has supported this program through its colloquium series, providing key resources, including Handbooks, APA guides for writing papers, and access to research materials. With our move to campus, we now offer ID-reader access to the Center, making these physical resources—including video cameras, tripods, and research equipment—available to PhD students for their projects.

Through these efforts, the Kaput Center continues to (re)established itself as a critical space for research development, providing essential support to both faculty and graduate students as they advance their scholarship in STEM education.

K-12 Outreach

The Kaput Center continued its commitment to K-12 outreach through research and practice support provided by various grants that run through the center. These grants allow us to offer valuable educational resources and STEM experiences to students, fostering early engagement in STEM disciplines.

In addition to our research-based initiatives, we organized a College and STEM Pathway Event for local high school youth, designed to provide guidance and inspiration for students interested in pursuing STEM careers and higher education. This event serves as a bridge between high school education and the future opportunities available in STEM, giving students access to resources, mentorship, and a clear vision of the paths they can take in college and beyond.

A highlight of our K-12 outreach was the annual STEM4Girls event. This year, we strengthened our partnership with two of the largest school districts in the region, New Bedford and Fall River, providing girls from these schools with priority registration for the event. By collaborating with these districts, we were able to ensure that girls from underserved communities had the opportunity to participate in hands-on STEM workshops, inspiring them to pursue further education and careers in STEM fields.

Through these outreach efforts, the Kaput Center continues to bridge gaps in STEM education, making STEM accessible to a diverse and broad group of students in the K-12 system.

STEM4Girls

We held our 11th annual STEM4Girls on Saturday, Oct 28, 2023. We had 170 registrations. Six school districts and one Girl Scout troop sent groups of girls plus we had 18 register online from around the area. We welcomed keynote speaker Stephanie Milam, who serves as the James Webb Space Telescope Deputy Project Scientist for Planetary Science; she opened the session talking about her work as a Planetary Scientist at NASA's Goddard Space Flight Center. This was followed by a fun warm-up session from Our Sisters School. From there, students attended two of the 20 workshops offered by our experts. At lunch we offered some hands-on experiences with robots and Norbert, 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 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.

Grant Proposal Activity

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

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: 9/1/2017-8/31/2025

Title: Computational Thinking Counts in Elementary Grades: Powerful STEM Teaching and Learning for the 21st Century
PIs: **Shakhnoza Kayumova** & Ramprasad Balasubramanian, Subaward from Rethinking Learning and PI: Chandra Orrill.
Funding Agency: National Science Foundation
Total Award: $2,116,315
Project Dates: 1/1/2020 – 12/31/2023

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

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

Grants Under Review 2023-24:

Title: Collaborative Research: Teaching for the Anthropocene: Teacher Learning and Practice for Critical Systems Thinking
PI: **Shakhnoza Kayumova** (with SUNY U of Buffalo as lead institution), Co-PI: Walter Stroup
Funding: National Science Foundation
Amount Requested: $1,573,969
Project Dates: 12/2024-12/2028

Title: Educators Participating In biodiversity- and climate-focused Citizen/Community Science (EPICS)
PI: **Stephen Witzig**; Co-PIs: **Robert Gegear**, Kathy Kavanagh
Funding: National Science Foundation
Amount Requested: $587,846
Project Dates: 6/2024-5/2028

Title: Building Bridges for Equity: Advancing Anti-Racist STEM Teaching in Secondary Education (Bridges-STEM)
PI: **Shakhnoza Kayumova**; Co-PIs: **Stephen Witzig**, Dilshod Achilov
Funding: National Science Foundation:
Amount Requested: $4,381,234
Project Dates: 8/2024-7/2029

Grants Not Funded 2023-24
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

Bazzul J., & Kayumova, S. (2018). The ethical subject of science education: Toward different ethicopolitico 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: Dortrecht, Netherlands. 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 40th 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 KnowledgeMaking-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 40th 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 40th 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. 351357). 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/s11422018-9861-5.

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* (5th 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 44th 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), 127145. 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

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 44th 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 nondidactic classrooms. In A. E. Lischka, E. B. Dyer, R. S. Jones, J. N. Lovett, J. Strayer, & S. Drown (Eds.), *Proceedings of the 44th 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/s11191-02200328-0.

2023

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

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., & Kahveci, E. N. (2023). Heterogenous Sensemaking: How Multilingual Girls and a Teacher Engaged in Joint Learning. In Proceedings of the 17th International Conference of the Learning Sciences-ICLS 2023, pp. 2067-2068. *International Society of the Learning Sciences*.

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

Rahm, J., Polman, J. L.,...Kayumova, S., & Gonsalves, A. (2023). Centering Critical Youth Research Methodologies of Praxis and Care in Post-Pandemic Times: From Respectful Relations and Dialogue Towards New Imaginaries. In *Proceedings of the 17th International Conference of the Learning Sciences-ICLS 2023, pp. 1622-1629*. International Society of the Learning Sciences.

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

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.

2024

Kayumova, S., & Buxton, C. (2023). Teacher subjectivities and multiplicities of enactment: Agential realism and the case of science teacher learning and practice with multilingual Latinx students. In *Non-Linear Perspectives on Teacher Development* (pp. 267-281). Routledge.

Liu, Z., Gearty, Z., Richard, E., Orrill, C. H., Kayumova, S., & Balasubramanian, R. (2024). Bringing computational thinking into classrooms: a systematic review on supporting teachers in integrating computational thinking into K-12 classrooms. *International Journal of STEM Education*, *11*(1), 51.

Hubelbank, J., Dubosarsky, M., Kayumova, S., Davis, T., Sann, N., Fortin, S., & Smith, G. (2024). Integrating computational thinking practices into early childhood education in culturally responsive ways: Insights from research–practice partnership. *Future in Educational Research*.

Zhao, Y., Liu, Z., Orrill, C., Kayumova, S., & Balasubramanian, R. (2023). Designing professional learning workshop for shaping teachers' learning pedagogical content knowledge in computational thinking. In *Proceedings of the 17th International Conference of the Learning Sciences-ICLS 2023, pp. 2071-2072*. International Society of the Learning Sciences.

Asif, A. D., Malik, H., Orrill, C., Balasubramanian, R., & Kayumova, S. (2024). Computational Thinking: Teachers' Practice of Abstraction. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 1826-1829*. International Society of the Learning Sciences.

Asif, A. D., Malik, H., Orrill, C…B., Balasubramanian, R., & Kayumova, S. (2024). Computational Thinking: A Tale of Debugging. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 2445-2446*. International Society of the Learning Sciences.

Kayumova, S., Raj, A., & Harper, A. (2024). I see myself as a Science Person: Insights into Science Identity Development Among Emergent Multilingual Youth. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 2507-2508*. International Society of the Learning Sciences.

Orrill, C., Gearty, Z., Brown, R. E., Kayumova, S., & Balasubramanian, R. (2024). One-on-One Coaching to Support Connection Making: Moving Professional Learning to Practice. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 1183-1186*. International Society of the Learning Sciences.

Liu, Z., Liu, R., Orrill, C., Kayumova, S., & Balasubramanian, R. (2024). Mapping the Complexities of Teacher Change: A Conjecture Mapping Approach to Designing Computational Thinking Professional Development. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 2255-2256*. International Society of the Learning Sciences.

Raj, A., Wittmann, M., & Kayumova, S. (2024). Being Fair & Equitable: A Qualitative Study of Science Teachers' Shifts in Priorities and Expectations During COVID-19. In *Proceedings of the 18th International Conference of the Learning Sciences-ICLS 2024, pp. 2283-2284*. International Society of the Learning Sciences.

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