



Kaput Center for  
Research and Innovation in STEM Education

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

## ANNUAL REPORT FY2020

KAPUT CENTER FOR  
RESEARCH AND INNOVATION IN  
STEM EDUCATION

JULY 31, 2020

## 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 FY20.

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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**

**EXECUTIVE BOARD AT END OF FY20**

Chairperson of the Board: Michael Goodman, Ph.D. <i>Associate Professor of Public Policy,</i> <i>UMass Dartmouth</i> Term Expires: 5/21	Ramprasad Balasubramanian, Ph.D. <i>Associate Provost for Decision Support &amp; Strategic Initiatives</i> <i>UMass Dartmouth</i> Term Expires: 9/21	Marylou T. Clarke, C.A.G.S. <i>Assistant Superintendent of Dartmouth Public Schools (Retired)</i> Term Expires: 05/22
Elizabeth Cullen <i>Director/Co-Founder Rhode Island STEAM Academy</i> Term Expires: 11/21	Paul Fredette, President & CTO – Promptus Communications CTO - American Doctors Online Term Expires: 11/21	Beste Güçler, Ph.D. <i>Associate Professor of Mathematics Education, UMass Dartmouth</i> Term Expires: 5/22
Rebecca L. Harrison, B.A. <i>Research Associate, UMass Dartmouth</i> Term Expires: 05/20	Shakhnoza Kayumova, Ph.D. <i>Associate Professor of Science Education, UMass Dartmouth</i> Term Expires:	Walter Stroup, Ed.D. <i>Associate Professor/Chairperson UMass Dartmouth</i> Term Expires: 9/20
Dave Welty, Ph.D. <i>Chair of STEM, Fairhaven Public Schools</i> Term Expires: 5/21	Stephen Witzig, Ph.D. <i>Assistant Professor of Science Education, UMass Dartmouth</i> Term Expires:	

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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 July 1<sup>st</sup> 2019 to June 30<sup>th</sup> 2020, which is Fiscal Year 2020. This document was prepared by Dr. Chandra Orrill, 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 14<sup>th</sup>, 2007 and it 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.

This report documents the ongoing work of the Kaput Center through FY2020 and new initiatives.

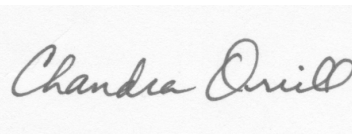
## Directors' End-of-Year Report FY2020

This is my final Annual Report as the Director of the Kaput Center. In this report, we, sadly, present more potential than action because FY20 was an unusual year for the Center. First, the Kaput Center moved from its original Fairhaven location to the Liberal Arts building on the UMass Dartmouth Campus. Then, as the dust settled from that move, the world was struck with the COVID-19 virus. The move to campus was consistent with the goals I had every year as Director: to increase faculty participation in the work of the Center and to increase the Center's presence in the region. We were on a path to make our efforts in relocating come to fruition with our first scheduled colloquium speaker coming from the UMass Dartmouth Biology department. And, to promote the Kaput Center in the region, we started some new events such as the STEM Technology Playground for Teachers, which was an exciting step toward connecting to more teachers around technology and computational thinking.

We added one grant to our portfolio this year. Professor Kayumova and I, along with Associate Provost Ram Bala, secured a \$2 million NSF grant to explore how to support computational thinking in upper elementary math and science classrooms. We have partnered with a local school district and are using the grant as a means to support needs related to science and mathematics education in a year of COVID.

We added two new Executive Board Members in FY20. Shakhnoza Kayumova and Stephen Witzig, both Science Educators in the STEM Education Ph.D. program joined the Executive Board.

As I've said in previous reports, the Kaput Center is a reflection of its people. My departure as Director will provide an opportunity for someone new to take the Kaput Center in a new direction. I have no doubt that the Executive Board will continue to provide the high-quality guidance they have offered me and I hope the faculty and students will continue to be involved. I want to thank the people who have supported me in the role of Director. Particularly, Kym Welty who has served as a sounding board for all my crazy ideas, Associate Provost Alex Fowler who has worked with me to find a sustainable funding model for the Center, Dean Pauline Entin who believes in the Center enough to help us finally move to campus, and all the students who have inspired me to make the Center the best it could be to serve them. And, of course, to the Executive Board, particularly Mike Goodman as Chair, who were always there to support my ideas and push me further than I would have otherwise gone. I am lucky to have had a community of people who believe in the mission of the Center to help me along the path of the last three years as Director plus the three years I spent co-directing the Center in the role of Administrative Director.



Chandra Orrill  
Director

## **Kaput Center Infrastructure**

### ***Executive Board & Duties***

The Executive Board consists 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. 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.

The Executive Board convenes quarterly. 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 are 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.

The Executive Board 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 Visting 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.

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. Membership is for three (3) years and renewable.



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

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 in consultation with the Executive Board, who are drawn from positions of leadership in the public, non-profit, and private sectors. The Board will assist in setting the Center's research agenda and in developing research resources. The Board will also advise and assist the Director and Executive board in developing strategic plans to achieve its mission that responds to educational need both locally, nationally and internationally in the field of STEM education. The Advisory Board are considered advocates of the Center, promoting the work of the Center and establishing new associations with leaders in STEM education research and innovation.

The Advisory Board has historically been extremely helpful in advising the Director in planning the Center's events and its operation more globally, particularly on realizing the scope and possibilities of how the Center can make an impact over time. Some advisors have also visited and assisted associates of the Center in their R&D programs, and hosted graduate students at their institutions.

### ***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 PhD student accepted onto the Doctoral Program in STEM Education at the University of Massachusetts Dartmouth who is appointed as a Research Assistant to a Center-based grant-funded project.

These positions are two-year, renewable appointments.

## *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:

- Several overhead projectors appropriate for use as needed
- 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
- More than a dozen Raspberry Pis, most in Pi-Top CEED cases that include a flatscreen monitor
- 2 Photon Robots
- HD/DV cameras
- Augmented reality sandbox

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 new website, went live in fall 2018. We own this URL for five years. The InterMath website conversion was also completed and we now own the intermath.org domain for five years. With Prof. Orrill's departure as Director of the Kaput Center, the InterMath website will become her responsibility and not the ongoing responsibility of the Kaput Center.

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://kaputcenter.libib.com>

### *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 FY20 was \$21,065 with operational expenses of \$44,291. The expenses above the operating budget were covered with Indirect funds. We end the year with \$17,836 left in the Indirect account.

<b>Expense Type</b>	<b>Description</b>	<b>Amount</b>
<b>Revenue</b>	University Support (Salaries, Fringe & Operational Budget)	\$ 21,064.86
	Indirect Revenue	\$ 12,567.05
	<b>Total Revenue</b>	\$ 33,631.91
<b>Direct Expenses</b>		
<b>Payroll</b>	Total Payroll FY20	\$ 25,513.86
Fringe	Fringe for FY20	\$ 9,978.19
	<b>Total Payroll FY20</b>	\$ 35,492.05
<b>Non-Payroll</b>		
Office/Admin Supplies	<b>Total Office &amp; Admin Supplies</b>	\$ 1,393.33
Employee Related Expenses	Travel	\$ 89.32
	<b>Total Employee Related Expenses</b>	\$ 89.32
Non-Employee Expenses	Travel	\$ 591.11
	Honoraria	\$ 0.00
	<b>Total Non-Employee Expenses</b>	\$ 591.11
Facility & Operations	Food & Beverage	\$ 208.65
	Research Supplies	\$ 1,932.79
	Books - Non Library	\$ 35.91
	<b>Total Facility &amp; Operations</b>	\$ 2,177.35
Printing Expenses	Engraved BOD plates	\$ 48.00
	Copier Expense	\$ 1,914.98
		\$ 44.00
	<b>Total Printing Expenses</b>	\$ 2,006.98
Conference Misc & Temp Space	S	\$ 1,326.84
	<b>Total Conference Misc &amp; Temp Space Expenses</b>	\$ 1,326.84
	<b>Total Postage &amp; Freight</b>	\$ 1.05
	<b>Total Telecom Services Voice</b>	\$ 1,212.66
	<b>Total Non-Payroll</b>	\$ 8,798.64
	<b>Total Direct Expenses</b>	\$44,290.69

Table 2: Revenue & Costs for FY20

## 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

There were six funded grants in the Kaput Center in FY20:

**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.

**Group-Based Cloud Computing for STEM Education.** This project was funded by the National Science Foundation DRK-12 program. Walter Stroup leads a four-campus team developing tools that allow students to engage in science and mathematics in the classroom using the collaborative computing power available through cloud-based solutions. This is an exploratory project seeking to demonstrate how group-based learning based in generative design can support learning.

**Proportions Playground: A Dynamic World to Support Teachers' Proportional Reasoning.** This project, also supported by the National Science Foundation, examines how dynamic environments support teachers in reasoning about proportional situations. This work grew out of Chandra Orrill's CAREER grant in which the researchers noticed that teachers approach the same mathematics in different ways in dynamic environment than they do using paper and pencil.

**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.

**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.

**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.

## ***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 ...*

Due to COVID-19, our symposium & colloquium series scheduled for Spring 2020 was postponed.

Full abstracts of the planned talks can be found in Appendix B.

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

## ***STEM4Girls (March 28, 2020 – postponed due to COVID-19)***

The 2020 STEM4Girls was planned to be the largest to date. As part of the effort, we had also added some new features. The day was to be extended and rearranged. As always, STEM4Girls would have opened with a Keynote speaker and presentation from Ms. Eugenio's students from Our Sisters School. Then, the girls would have attended their first workshop. Lunch was to be done in two groups. While one group ate lunch, the other would attend a question and answer session with women in STEM. Also, during lunch, we had plans for several hands-on exhibits for the girls to have even more opportunities to engage with STEM ideas. After lunch, the girls were to attend a second workshop. The day was to end with a presentation from New Bedford's STEAM the Streets. As part of the event, we had 24 workshops planned and had recruited 39 volunteers. As part of the planning effort, we had restructured both the physical check-in space and the check-in process to expedite the girls getting into the event. We had also planned a more organized release process that included releasing the girls in waves rather than all at once. These were efforts to streamline processes and ensure the girls were safely returned home at the end of the day. We also worked with our school partners to ensure schools in Fall River and New Bedford had more access to the event. This would have also allowed us to deliver t-shirts to the girls before the event as well as to recruit school-based chaperones to help with intake efforts. In all, we anticipated having 225 girls attend the event.

## ***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 Center has supported the program through its support of graduate students on funded grant projects, the colloquium series, and through volunteer opportunities such as STEM4Girls and CodeDojo. The Kaput Center has also made 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 of 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.

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

In FY20, the Kaput Center engaged in a couple new outreach activities. First, in celebration of STEM Week, we did an after-school Technology Teacher Playground in which we prepared an array of technologies for teachers to try out in a safe, hands-on way. While we did not attract as many teachers as we wanted, we did draw a lot of attention from undergraduate students at UMass Dartmouth who wanted to explore the technologies. We hope to build from this experience to become a more active member of the UMass Dartmouth campus.

The Kaput Center also worked at the Technology Playground sponsored by Eduscape at MassCUE. In this role, we had an opportunity to talk to numerous teachers about a variety of technologies they might want to use in their classrooms.

We continued running the CoderDojo until COVID-19 made it impossible to meet. Through some modifications, we had gotten a pretty steady attendance of 14-20 students and we had a cadre of volunteers that included teachers and other community members as well as graduate students. We had implemented a plan to incorporate more diverse set of technologies that included incorporating Little Bits, robots, and circuit activities into the sessions for students who were interested.

While we did some STEM Day support in local schools, many of those events were disrupted by the pandemic.

## Grant Proposal Activity

### *Funded Proposals*

Title: Proportions Playground: A Dynamic World to Support Teachers' Proportional Reasoning

PI: Chandra Orrill

Funding Agency: National Science Foundation (DRK-12)

Amount: \$783,337

Project Dates: 9/1/2016-2/28/20

Title: Group-Based Cloud Computing for STEM Education

PI: Walter Stroup

Co-PI: Corey Brady (Vanderbilt U), Anthony Petrosino (UT-Austin), and Uri Wilensky (Northwestern U)

Funding Agency: National Science Foundation (DRK-12)

Amount: \$1,045,549

Project Dates: 9/2016-8/2020 (including no cost extension year)

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

Amount: \$2.1 million

UMass Dartmouth Award Amount: \$377,973

Project Dates: 6/1/18-5/31/22

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

UMass Dartmouth Award Amount: \$237,413

Project Dates: 7/1/18-6/30/22

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: 9/1/2017-8/31/2022



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 & Ramprasad Balasubramanian (Computer Science)

Funding Agency: National Science Foundation

Amount Requested: \$2,116,315

Project Dates: 1/1/20 – 12/31/23

### ***Proposals Under Review***

Title: The Accelerated Engineering Leadership (AccEL) Project.

PI: T. Ferreira CoPI : Shakhnoza Kayumova.

Funding Agency: NSF SSTEM Program.

Amount Requested: \$999,996.

Status: Under Review.

Title: Changing the Narrative: Engaging in the VR World of Hoover Dam to Explore Science, Engineering, and Social Justice Issues of Innovation and Struggle.

Funding Agency NEH Co-PI: National Endowment for the Humanities, Digital Projects for the Public Prototyping Grant.

PI: Anthony Arrigo CoPI: Shakhnoza Kayumova.

Amount Requested: \$99,541.

Status: Under Review.

Title: S-STEM ACCOMPLISH: Academically Capable COMPUTation-focused Low-Income Student coHort.

PI: Yanlai Chen, Co-PI: Pauline Entin, Sigal Gottlieb, Shakhnoza Kayumova, Gaurav Khanna.

Funding Agency: NSF.

Amount Requested: \$650,000.

Status: Under Review.

Title: Increasing Massachusetts Partnerships for Advancing Computational Thinking in PK-5 Classrooms (IMPACT PK-5).

PI: Mia Dubosarsky, Co-PI: Shakhnoza Kayumova, Co-PI: Gillian Smith

Funding Agency: NSF (Computer Science for All).

Amount Requested: \$297,410.

Status: Under Review.

## ***Unfunded Proposals***

Title: Active Sensing in Echo Locating Marine Mammals and Humans  
PI: Kathleen Wage (George Mason University); Other Partner Institutions: Brigham Young University, Louisiana Tech University, and University of Rhode Island  
Subaward: John Buck (Electrical Engineering – PI on UMassD Subaward); Shakhnoza Kayumova (Subaward co-PI)  
Funding Agency: Office of Naval Research  
Amount Requested: \$749,465  
UMassD Amount Requested: \$93,503  
Project Dates: 6/1/2020-5/31/2023  
Date Submitted: 9/20/2019

Title: Students Engaged in Naval Systems through Original Research in STEM (SENSORS)  
PI: Stephen Witzig  
Co-PI's: Cynthia Pilskaln (SMAST) & Alex Fowler (Research & Economic Development)  
Funding Agency: Office of Naval Research  
Amount Requested: \$747,796  
Project Dates: 6/1/2020-5/31/2023  
Date Submitted: 9/27/2019

Title: AISL Innovations in Development: CAI-Youth: Community- Based Artificial Intelligence Education with Children and Youth  
PI: Shakhnoza Kayumova  
Co-PI's: Lance Fionella, Ricardo Rosa,  
Subaward: Pratim Sengupta, Marie-Claire Shanahan (University of Calgary \$342,109)  
Funding Agency: National Science Foundation  
Amount Requested: \$1,917,940  
Project Dates: 7/1/2020-6/30/2023  
Date Submitted: 11/6/2019

## Publications of the Kaput Center (2010-2020)

### 2010

- Hegedus, S. J., & Moreno-Armella, L. (2010). Accommodating the Instrumental Genesis Framework Within Dynamic Technological Environments. *For the Learning of Mathematics*, 30(1), 26-31.
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- **Introduction: Major Themes, Technologies, and Timeline**  
Jeremy Roschelle and Stephen Hegedus
- **From Static to Dynamic Mathematics: Historical and Representational Perspectives**  
Luis Moreno-Armella and Stephen Hegedus
- **Intersecting Representation and Communication Infrastructures**  
Stephen Hegedus and Luis Moreno-Armella
- **Reflections on Significant Developments in Designing SimCalc Software**  
James Burke, Stephen Hegedus, and Ryan Robidoux
- **SimCalc and the Networked Classroom**  
Corey Brady, Tobin White, Sarah Davis, and Stephen Hegedus
- **Learning and Participation in High School Classrooms**  
Sara Dalton and Stephen Hegedus
- **Impact of Classroom Connectivity on Learning and Participation**  
Stephen Hegedus, Luis Moreno-Armella, Sara Dalton,  
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- **Connection Making: Capitalizing on the Affordances of Dynamic Representations Through Mathematically Relevant Questioning**  
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# **APPENDIX A**

Advisory Board

## ADVISORY BOARD

Advisors are not members of the Executive Board, and do not necessarily have associations with the Center, although that is possible. The Center has an international and interdisciplinary advisory board, which consists of the following members:

### AUSTRALIA

Lyn English - *Queensland University of Technology*

### BRAZIL

Tânia Maria Mendonça Campos - *UNIBAN São Paulo*  
Ubiratan D'Ambrosio  
Lulu Healy - *UNIBAN São Paulo*  
Rosana Nogueira de Lima - *UNIBAN São Paulo*

### CANADA

Nathalie Sinclair - *Simon Fraser University*

### CYPRUS

Constantinos Christou - *University of Cyprus*  
Nicholas G. Mousoulides - *University of Cyprus*  
Demetra Pitta-Pantazi - *University of Cyprus*

### FRANCE

Nicolas Balacheff - *Laboratoire Leibniz*  
Raymond Duval  
Colette Laborde - *Equipe IAM*  
Jean-Marie Laborde - *Cabrilog*

### GERMANY

Michael Otte - *Bielefeld University*  
Falk Seeger - *Bielefeld University*

### GREECE

Chronis Kynigos - *University of Athens*  
Joanna Mamona-Downs - *University of Patras*

### ISRAEL

Tommy Dreyfus - *Tel Aviv University*  
Ana Sfard - *University of Haifa*  
Dina Tirosh - *Tel Aviv University*  
Pessia Tsamir - *Tel Aviv University*  
Shlomo Vinner - *Ben Gurion University*  
Michal Yerushalmy - *University of Haifa*

### ITALY

Ferinando Arzarello - *Università di Torino*

### MEXICO

Teresa Rojano - *ILSE*  
Patricia Salinas - *Tecnológico de Monterrey*

### SINGAPORE

Sarah Davis - *National Institute of Education*  
Chee-Kit Looi - *National Institute of Education*

### SWEDEN

Per Nilsson - *Linnaeus University*  
Håkan Sollervall - *Linnaeus University*

### SWITZERLAND

Christof Weber - *FHNW*

### UNITED KINGDOM

Celia Hoyles - *University of London*  
Barbara Jaworski - *Loughborough University*  
Keith Jones - *University of Southampton*  
John Mason - *Open University*  
Richard Noss - *London Knowledge Lab*  
David Tall - *University of Warwick*

### USA

Nancy Ares - *University of Rochester*  
Yaneer Bar-Yam - *New England Complex Systems Institute*  
Hyman Bass - *University of Michigan*  
Corey Brady - *Vanderbilt University*  
David Carraher - *TERC*  
Allan Cohen - *University of Georgia*  
Jere Confrey - *North Carolina State University*  
Al Cuoco - *Educational Development Center*  
Chris Dede - *Harvard University*  
William Finzer - *KCP Technologies*  
Megan Franke - *University of California, Los Angeles*  
Paul Goldenberg - *Educational Development Center*  
Gerald Goldin - *Rutgers University*  
Charles Goodwin - *University of California, Los Angeles*  
Rogers Hall - *Vanderbilt University*  
Eric Hamilton - *United States Air Force Academy*

Guershon Harel - *University of California, San Diego*  
Steve Harrison - *Virginia Tech*  
Eric Heller - *UMass Donahue Institute*  
Andrew Izsák – *Tufts University*  
Nicholas Jackiw - *KCP Technologies*  
David Kirshner - *Louisiana State University*  
Eric Knuth - *University of Wisconsin, Madison*  
Cliff Konold - *University of Massachusetts Amherst*  
Richard Lesh - *University of Indiana*  
Marcia Linn - *University of California, Berkeley*  
Joanne Lobato - *San Diego State University*  
Fred Martin - *University of Massachusetts Lowell*  
James Middleton - *Arizona State University*  
Ricardo Nemirovsky - *San Diego State University*  
William Penuel - *SRI International*  
Norma Presmeg - *Illinois State University*  
Steve Rasmussen - *KCP Technologies*  
Jeremy Roschelle – *Digital Promise*  
Nora Sabelli - *SRI International*  
Adalira Sáenz-Ludlow - *University of North Carolina, Charlotte*  
Deborah Schifter - *Educational Development Center*  
Analucia Schliemann - *Tufts University*  
Roberta Schorr - *Rutgers University*  
Judah Schwartz - *Tufts University*  
Annie Selden - *New Mexico State University*  
John Selden - *New Mexico State University*  
David Williamson Shaffer - *University of Wisconsin, Madison*  
Finbarr Sloane - *Arizona State University*  
Judith Sowder - *San Diego State University*  
Denise S. Spangler - *University of Georgia*  
Bharath Sriraman - *University of Montana*  
Walter Stroup - *University of Texas, Austin*  
Despina Stylianou - *City College of New York*  
John Tapper - *University of Hartford*  
Deborah Tatar - *Virginia Tech*  
Jonathan Templin - *University of Georgia*  
Phil Vahey - *SRI International*  
Keith Weber - *Rutgers University*



## **APPENDIX B**

Abstracts of Symposium & Colloquium Series

**SYMPOSIUM & COLLOQUIUM SERIES  
(2019-2020)**

*Postponed due to COVID-19*

**Computational Heterogeneity in STEM Education**

Dr. Pratim Sengupta, Professor and Research Chair of STEM Education at the University of Calgary

Abstract: In this talk, I will present research conducted collaboratively with Dr. Amanda Dickes, Dr. Amy Farris and Dr. Marie-Claire Shanahan. While the acronym “STEM” offers new possibilities of multi-disciplinarity, our work arises from the concern that notions of knowing and disciplinary work in STEM education research by and large remain grounded in technocentric and individualistic approaches. In contrast to these images, we will present multivoiced illustrations of computational work in STEM classrooms and public spaces. We will discuss a few themes that emerge from this work, that include: the centrality of the mathematical modeling in bringing together computing and science and supporting teacher voice, the role of materiality and perspectives in developing expertise with symbolic forms, and the importance of emotionwork and carework in computational design. Collectively, these images offer an imagination of computational heterogeneity and can also orient us in ways that can counter technocentrism and individualism in STEM education.

**The Bio-CS Bridge: A Transdisciplinary Team Approach to Integrating Biology and Computer Science in High School Curricula**

Dr. Robert Gegear, Professor in the Department of Biology at University of Massachusetts Dartmouth

Abstract: Pollinators are declining at an unprecedented rate worldwide for unknown reasons. These declines pose a significant threat life on our planet due to the critical role that pollinators play in maintaining ecosystem health and biodiversity. The Beecology citizen science research project aims to improve pollinator conservation efforts in North America through the rapid collect of ecological data on species at risk. I will discuss how the Beecology Project is being used to create a fully integrated STEM+C high school curriculum (the BIO-CS Bridge) that combines scientific practices such as experimental design and hypothesis testing with computational thinking and skills such as modeling, simulation, and systems approaches to biology. I will also highlight and demonstrate some of the freely available BIO-CS Bridge educational tools that we have developed for teachers, which include a mobile webapp, computer simulations, online data visualization tools, and other online resources. This work provides a blueprint for the use of transdisciplinary team science to develop highly effective integrated curriculum in many content areas.