UMass | Dartmouth
Kaput Center for
Research and Innovation in STEM Education

200 Mill Rd., Suite 150B
Fairhaven, MA 02719, USA

ANNUAL REPORT FY2019

KAPUT CENTER FOR
RESEARCH AND INNOVATION IN
STEM EDUCATION

June 27, 2019

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 FY19.

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

http://kaputcenter.org

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.

Chandra Orrill, Ph.D. – Director

EXECUTIVE BOARD AT END OF FY19

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

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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 July 1st 2018 to June 30th 2019, which is Fiscal Year 2019. This document was prepared by Dr. Chandra Orrill, Director of the Center.

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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.

This report documents the ongoing work of the Kaput Center through FY2019 and new initiatives.

Directors' End-of-Year Report FY2019

I present this annual report that shows the collective work of the people of the Kaput Center: faculty, students, staff, and Executive Board Members. The two main foci for FY2019 were consistent with FY2018: to increase faculty participation in the work of the Center and to increase the Center's presence in the region. In the area of faculty inclusion, there are two main items to report. First, the second half of the year featured two colloquia that highlighted guest speakers identified by the faculty. The faculty selected speakers who they would like to work with and the nominating faculty member in each case was able to have a two-hour block of meeting time with the guest speaker to talk about potential initiatives. Second, we have begun doing considerable outreach around our events to the campus. This included more outreach for STEM4Girls to bring in faculty and students from other departments as well as more advertising to other departments about our speaker series. This was reasonably successful with the highest participation of non-Kaput Center faculty being at Dr. Kristy Daniel's colloquium – which was also the only colloquium held on campus. As part of Dr. Daniel's visit, we not only had science, engineering, and mathematics faculty in attendance at the talk, but also were able to have Dr. Daniel meet with a faculty member and graduate students in the Biology department to talk about her research on teaching and learning Biology.

The second area of focus was creating more of a presence in our region. This effort has included creating a CoderDojo, which is a computer programming club for students aged 7-17. Our Dojo meets monthly on a Saturday and is supported by volunteers from UMass Dartmouth and the community. Our Dojo has reached 66 students. While most of these students have only attended one CoderDojo meeting, 28 students have come more than once and one has attended every meeting. The mentors are making plans to refine aspects of the CoderDojo as we move into our second year with the goal of increasing the number of repeat attenders. We also expanded our STEM4Girls event to reach even more girls. This year, we had 250 girls sign up and 205 attend. Again, this was supported by volunteers from the university and the broader community. We had a total of 23 workshops, four panel members, and Dr. Jean VanderGheynst, Dean of the College of Engineering at UMass Dartmouth, served as our keynote speaker. A team of middle school students from Our Sisters School also prepared an opening session that included jokes, trivia, and dancing to get all the girls ready for the day.

Our outreach also extended off campus as we participated in STE(A)M events at three area schools, I served as an invited panelist in Dell's *MassForward: A Vision for the 2030 Agenda* event and in a video for Comcast's *Newsmakers* series. In addition to this, Shakhnoza Kayumova, Stephen Witzig, and I also presented a session about STEM4Girls at the MA STEM Summit. We also continued our newsletter, which is published at the end of each academic semester.

Following last year's success with grants, this year was quieter, in part because the funded PIs were running those new grants. Professor Witzig's NSF-funded Teach SouthCoast STEM grant ended in the fall. Professor Stroup continues to lead a $1million DRK-12 grant which will end in

Fall 2019. Professor Kayumova leads an NSF CAREER grant worth $779,000; and, I lead an NSF-funded DRK-12 grant for $738,337 that ends in February 2020 as well as serving as Co-PI on an NSF grant and an IES grant based at the University of Southern California.

Our colloquium theme this year was looking across the STEM fields as we celebrated the beginning of the STEM Education Ph.D. program at UMass Dartmouth. In all, we hosted three colloquia.

We added two new Executive Board Members in FY18. We are fortunate to be joined by Beth Cullen, the Founder and Director of the Rhode Island STEAM Academy and Ram Bala, the Associate Provost for Decision Support and Strategic Initiatives at UMass Dartmouth. Both of these new members has already made important contributions to the Center.

As always, the Kaput Center is a reflection of its people. The faculty, staff, and students who work together to create the Center help keep it alive and evolving year after year. This year, more than ever, I have relied on members of the Kaput Center family to make our ideas come to life. From our Grants Support Specialist, Kym Welty, who does so much for all of our events to the graduate students, board members, and community members who instantly agreed to support my crazy idea of starting a CoderDojo, I am lucky to have a community of people who believe in the mission of the Center and find ways to contribute their time and talent to that mission.

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,
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> 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.
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> 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

At the end of FY14, the Kaput Center space was reduced so that it now occupies approximately 2100 square feet at a rented facility in Fairhaven, MA. In FY2017, we were forced to relinquish our conference room, but were given access to the conference room in the space previously occupied by the Center for Marketing Research. The lease for our current space ended in August 2017. Current plans include moving the Kaput Center to campus in Fall 2019 to a much smaller space. While everyone acknowledges that the new space is not ideal or sufficient, we believe the need to have the Kaput Center on campus where it can serve as the physical hub of STEM activities is more important than maintaining the additional space off campus.

The Kaput Center has a variety of equipment intended to support the research and outreach mission. This equipment includes:

- Gigabit connectivity within the Center and secure 802.11a/b/g/n wireless connectivity
- Several projectors appropriate for use as needed
- 7-computer Apple Wireless Learning Lab with a suite of mathematical and mathematics educational software (e.g., Mathematica, Maple, Matlab, SPSS, Geometer's Sketchpad®, Cabri, MS Office, Adobe, Macromedia, etc.)
- iPads for use on research projects including 4 purchased in FY19
- 6 Chromebooks for use in research projects purchased in FY19
- More than a dozen Raspberry Pis, most in Pi-Top CEED cases that include a flatscreen monitor
- 2 Photon Robots
- HD/DV cameras

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.

In addition to these technical facilities, the Kaput Center has a large library that supplements the Campus library facility and which includes many Mathematics Education journals and periodicals dating back 20+ years. We have access to these resources and a full searchable electronic bibliography of these materials. The Center will continue to add cutting edge, contemporary, and cross-disciplinary literature that is not always available on the main University Campus. The Center's library houses over a thousand books covering areas of: 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, and Quantitative and Qualitative Methodology

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 FY19 was $51,781 with operational expenses of $62,280. The expenses above the operating budget were covered with Indirect funds. We end the year with $27,877 left in the Indirect account.

Expense Type	Description	$$
Revenue	University Support (Salaries, Fringe & Operational Budget)	$ 35,108.10
	Indirect Revenue	$ 15,609.68
	Development	$ 1,064.00
	Total Revenue	$ 51,781.78
Direct Expenses		
Payroll	Total Payroll FY19	$ 20,972.36
Fringe	Fringe for FYI 19	$ 7,900.19
	Total Payroll FY19	$ 28,872.55
Non-Payroll		
Office/Admin Supplies	**Total Office & Admin Supplies**	$ 837.93
Employee Related Expenses	Travel	$ 3,618.06
	Total Employee Related Expenses	$ 3,618.06
Non-Employee Expenses	Travel	$ 4,857.83
	Honoraria	$ 1,500.00
	Total Non-Employee Expenses	$ 6,357.83
Facility & Operations	Food & Beverage	$ 579.53
	T-shirts (STEM4Girls)	$ 2,147.60
	Research Supplies	$ 3,813.71
	Books - Non Library	$ 155.98
	Technology	$ 3,243.85
	Website/Cloud	$ 2,875.00
	Total Facility & Operations	$ 12,815.67
Printing Expenses	Kaput Center Logo Stickers	$ 456.87
	Copier Expense	$ 1,818.74
	Total Printing Expenses	$ 2,275.61
Conference Misc & Temp Space	STEM4Girls	$ 6,215.25
	Total Conference Misc & Temp Space Expenses	$ 6,215.25
	Total Postage & Freight	$ 77.89
	Total Telecom Services Voice	$ 1,178.24
Overhead	Bank Charges on Gifts	$ 31.92
	Total Overhead	$ 31.92
	Total Non-Payroll	$ 33,408.40
	Total Direct Expenses	$ 62,280.95

Table 2: Revenue & Costs for FY19

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 FY 19:

Teach SouthCoast STEM. This project was funded by the National Science Foundation and moved to the Kaput Center in FY 2016 under PI Stephen Witzig. The grant includes 21 Master Teaching Fellows and Teaching Fellows. The goals of the project are to (1) deepen educators' STEM content knowledge and instructional practices through content-intensive learning experiences; (2) develop critical 21st Century Skills through active exploration of emerging technologies; and (3) develop participants' teacher leadership skills.

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.

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 …

In honor of the new STEM Education Ph.D. program, this year's theme was focused on looking across the STEM domain. To this end, we featured three guest speakers this year.

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

Drawn into Science through Mystery and Awe
Janet L. Kolodner, Ph.D., Visiting Professor & Special Projects at Boston College
October 22, 2018

Science Practitioners Engaging in and Explaining Research as Scholars (SciencePEERS)
Kristy Daniel, Ph.D., Associate Professor, Department of Biology, Texas State University
April 19, 2019

I DO (NOT) Belong: Experiences of Black Women and Girls in Mathematics Education
Nicole Joseph, Ph.D., Assistant Professor of Mathematics Education, Department of Teaching and Learning, Vanderbilt University
May 6, 2019

All of the Colloquium talks are available on the Kaput Center YouTube channel.

STEM4Girls (March 30, 2019)

On Saturday, March 30, 2019, the Kaput Center, hosted the annual STEM4Girls event on the campus of the University of Massachusetts Dartmouth campus. This year, we invited girls in grades 3-8. We had about 205 girls in attendance, with 250 registered. The day was begun with a keynote from Dr. Jean VenderGheysnt, the Dean of the College of Engineering at UMass Dartmouth. The keynote was followed by a show put on by students from Our Sisters School that included a dance, some trivia, and other activities to get the girls excited. Each girl then participated in one or two workshops and we wrapped up the day with an all-woman panel that included representatives from a wide range of STEM careers. One reporter summed up STEM4Girls as follows:

> If the goal of STEM4Girls is to achieve this energy, where the students and instructors connect on a visceral and intellectual level, then consider the goal achieved. Or, more simply, STEM4Girls is great, not good. (Montana Samuels, March 30, 2019 *SouthCoast Today)*

Newspaper articles about STEM4Girls are available here:

- Girls Learn there is a place in STEM for them at UMass Dartmouth: https://dartmouth.theweektoday.com/article/girls-learn-there-place-stem-them-umass-dartmouth/40441?fbclid=IwAR1ThRAABGV6TfWEhjP4lBibCrd34QlLAeIsj3aGnY-qISvOVGEDWLP1Ekw
- Attendance at UMass Dartmouth STEM4Girls doubled from last year https://www.southcoasttoday.com/news/20190330/attendance-at-umass-dartmouth-stem4girls-doubled-from-last-year?fbclid=IwAR1yIyRitqhx8qtzAD4LjYrf4ih_I_iA7bUsaXoSawiOSsGpxhvwDl3RsJ4

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.

Grant Proposal Activity

Funded Proposals

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: 9/2016-8/2019

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: 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

Proposals Under Review

Title: Computational Thinking Counts in Elementary Grades: Powerful STEM Teaching and Learning for the 21st Century
PI: Chandra Orrill
Co-PIs: Shakhnoza Kayumova & Ram Bala (Computer Science)
Funding Agency: National Science Foundation
Amount Requested: $2,116,313
Project Dates: 1/1/20 – 12/31/23
Submitted Date: 5/1/19

Unfunded Proposals

Title: Master Teach! SouthCoast STEM
PI: Stephen Witzig
Co-PIs: Shakhnoza Kayumova, Chandra Orrill, Jay Wang
Funding Agency: National Science Foundation
Amount Requested: $1,497,012
Project Dates: 6/1/2019-5/31/2024
Due Date: 8/28/18

Publications of the Kaput Center (2009-2019)

2009

Hegedus, S. J., & Moreno-Armella, L. (Eds.) (2009). Transforming Mathematics Education through the Use of Dynamic Mathematics Technology. *Special issue of ZDM: The International Journal on Mathematics Education*, August 2009, Vol. 41, Issue 4.

Sriraman, B., & English, L. (Eds.) (2009). *Theories of Mathematics Education: Seeking New Frontiers.* New York: Springer.

Stylianou, D. A., Blanton, M. L., & Knuth, E. J. (Eds.) (2009). *Teaching and Learning Proof Across the Grades: A K-16 Perspective*. New York/Washington, DC: Routledge/National Council of Teachers of Mathematics.

Tapper, J. (2009, August). Evaluating Teacher Perceptions of the SimCalc Connected MathWorlds Intervention (Report). Hadley, MA: UMass Donahue Institute.

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.

Izsák, A., Orrill, C. H., Cohen, A. S., & Brown, R. E. (2010). Measuring Middle Grades Teachers' Understanding of Rational Numbers with the Mixture Rasch Model. *The Elementary School Journal, 110*(3), 279-300.

Roschelle, J., Shechtman, N., Tatar, D., Hegedus, S., Hopkins, B., Empson, S., Knudsen, J., & Gallagher, L. P. (2010). Integration of Technology, Curriculum, and Professional Development for Advancing Middle School Mathematics: Three Large-Scale Studies. *American Educational Research Journal*, published online June 2, 2010. doi: 10.3102/0002831210367426.

Sriraman, B., Bergsten, C., Goodchild, S., Palsdottir, G., Sondergaard, B. D. & Haapasalo, L. (Eds.) (2010). *The First Sourcebook on Nordic Research in Mathematics Education: Norway, Sweden, Iceland, Denmark and Contributions from Finland*. Charlotte, NC: Information Age Publishing.

2011

Ambrose, D., Sternberg, R., & Sriraman, B. (Eds.) (2011). *Confronting dogmatism in gifted education*. New York: Routledge.

Hegedus, S., & Moreno-Armella, L. (2011). The emergence of mathematical structures. *Educational Studies in Mathematics, 77*(2-3), 369-388.

Lee, S., Brown, R. E., & Orrill, C. H. (2011). Mathematics teachers' reasoning about fractions and decimals using drawn representations. *Mathematical Thinking and Learning, 13*(3), 198-220.

Sriraman, B., & Fyhn, A. B. (2011, May). Circumpolar indigenous issues, knowledge, relations to education, science and mathematics (Special Issue). *Interchange, 42*(2).

Sriraman, B. (Ed.) (2011). *Crossroads in the history of mathematics and mathematics education*. Charlotte, NC: Information Age Publishing.

Tapper, J. (2011, September). Democratizing Access to Core Mathematics Across Grades 9-12: Validity Study of Algebra 1 Content Tests. (Report). Hadley, MA: UMass Donahue Institute.

2012

Campbell, T., Longhurst, M., Duffy, A., Wolf, P., & Nagy, R. (2012). Investigating human impact in the environment with faded scaffolded inquiry supported by technologies. *Science Activities: Classroom Projects and Curriculum Ideas, 49*(4), 99-107.

Güçler, B. (2012). Limitless ways to talk about limits: Communicating mathematical ideas in the classroom. *Mathematics Teacher, 105*(9), 697-701.

Hegedus, S., & Roschelle, J. (2012). Highly adaptive, interactive instruction: Insights for the networked classroom. In C. Dede & J. Richards (Eds.), *Digital teaching platforms: Customizing classroom learning for each student* (pp. 103-116). New York: Teachers College Press.

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- **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, Arden Brookstein, and John Tapper
- **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 - *Universitá 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*
Häkan 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
(2018-2019)

Drawn into Science through Mystery and Awe

Janet L. Kolodner, Ph.D.
Visiting Professor and Special Projects, Lynch School of Education, Boston College
Regents' Professor Emerita, Computing and Cognitive Science, GA Institute of Technology
Editor-in-Chief Emerita, *The Journal of the Learning Sciences*
October 22, 2018

Abstract: In 2016, we set out to begin to understand how to design project challenges and the immersive worlds (virtual or real) in which they are addressed in ways that would encourage knowledge integration across projects students were working on, different topical areas in science they were encountering, and even different scientific disciplines. Informed by what is known about knowledge integration and remembering, we sought to understand the influences on the richness of learners' memories of what they were experiencing. Our context was 6th graders learning about pond ecosystems using Harvard's EcoMUVE. We observed students during their two weeks using EcoMUVE and then interviewed them 2 and 3 weeks later to understand what they remembered that would allow
such connection making and the circumstances during an interview when they would refer back to what they had learned. We learned a lot about both and discovered, too, that the combination of mystery, agency to explore, opportunities for experiencing awe, and responsiveness to the curiosity of learners was quite powerful in helping students connect science to their own lives, giving them a sense that they could, indeed, successfully do science, and leading some to think about how they would put to use the scientific practices they were learning.

Science Practitioners Engaging in and Explaining Research as Scholars (SciencePEERS)

Kristy Daniel, Ph.D.
Associate Professor, Department of Biology, Texas State University
April 19, 2019

Abstract: When scientists share their research with others, what they intend to say is not always what is actually understood. This is especially true when using visual images. Dr. Kristy Daniel's research explores issues that cause gaps in communication and identifies ways to build bridges facilitating methods to ensure the intended message is the same as the understood message. Her goal is to help make science accessible to more people by creating better messengers. In this talk, Dr. Daniel will share research from her lab focusing on communicating science as a learning process within the framework of representational competence, how people interpret and use visual diagrams to share understandings of science concepts. Be warned, Dr. Kristy Daniel loves to talk nerdy! She pushes budding researchers to be thoughtful about the language and images they use to share their passions and communicate the wonders of science.

I DO (NOT) Belong: Experiences of Black Women and Girls in Mathematics Education

Nicole Joseph, Ph.D.
Assistant Professor of Mathematics Education, Department of Teaching and Learning, Vanderbilt University
May 6, 2019

Abstract: The experiences of Black women and girls in mathematics is an understudied line of inquiry. We know very little about how they experience mathematics teaching and learning. The aim of this interactive talk is to problematize and interrogate the current circumstances surrounding Black women and girls in mathematics that deny them access, power, participation, and opportunity to develop mathematics identities.

APPENDIX C

Kaput Center Newsletters

Kaput Center
UMass Dartmouth

STEM-ester in Review

Kaput Center Newsletter

Welcome

Fall 2018 has flown by and we have been busy doing STEM and planning some exciting new adventures . This newsletter will get you updated on some of the most exciting things we've been doing, with many more to come in Spring 2019. You can always email us at kaputcenter@umassd.edu or check us out on the website http://kaputcenter.org. We also have Facebook and Twitter accounts: http://facebook.com/kaputcenter and https://twitter.com/kaputcenter

Please like us and share frequently and widely.

New People

The Kaput Center is delighted to welcome Ram Bala and Beth Cullen to our Executive Board. We look forward to our work together!

UMassDartmouth begins STEM Education Ph.D. Program

By: Stephen Witzig, Associate Professor - Science Education

In summer of 2018, the Massachusetts Board of Higher Education gave the final approval necessary to UMass Dartmouth's Department of STEM Education and Teacher Development to begin to offer a PhD in STEM Education. This significantly expanded the existing PhD program in Mathematics Education by adding concentration areas in Science Education in addition to Mathematics Education with the ability to add Engineering Education in the near future. The expanded program attracted the attention of potential students, as there was a spike in applications. The result was a 2018/2019 cohort of nine new doctoral students in the program – the largest cohort since the 2012/2013 academic year.

The new doctoral students interest in STEM Education

add to the research interests of the existing students and align well with the faculty research conducted at the Kaput Center for Research and Innovation in STEM Education. The Kaput Center serves as an incubator for ideas, a meeting space for students and faculty, and a research facility that fosters cutting-edge research in STEM Education. The synergy between the Kaput Center and the STEM Education PhD program was intentional. This synergy benefits the students, the faculty, as well as the local, national, and international STEM Education community at large.

The STEM Education PhD program is designed to develop scholars who are experts in current, innovative research practices and who have been well-prepared for diverse careers in higher education, research institutions, or industrial settings that are focused on improving educational attainment in mathematics, science, or other STEM-related subjects. A tight integration of curriculum and research provides critical authentic learning experiences through coursework, seminars, and internships both at UMass Dartmouth and at other academic institutions and non-academic partners. In this way, the program addresses key contemporary educational challenges, offering future STEM educators advanced training and experience. For more information about the program, including how to apply, see: https://www.umassd.edu/programs/stem-education-phd/ and feel free to reach out to any of the faculty to answer questions you may have.

STEM Summit

By: Shakhnoza Kayumova, Assistant Professor - Science Education

The Kaput Center for Research and Innovation in STEM Education's Director Dr. Chandra Orrill and research scientists Drs. Stephen Witzig and Shakhnoza Kayumova presented at the Massachusetts STEM Summit 2018 and shared their experience in organizing and running the annual STEM4Girls event hosted by the Kaput Center. The session was very well attended with an audience close to 150 people included organizations, schools, teachers, and educational leaders interested creating STEM outreach opportunities for diverse learners, and particularly girls. Dr. Orrill and colleagues shared with the audience their insights and experiences running STEM4Girls outreach program, including information about recruitment, ensuring diversity of participants, building partnerships with faculty in other colleges and teachers in schools, and planning the event to capitalize on the resources of the university. Dr. Orrill presented findings from the survey of participants and volunteers about what worked and what didn't work as well as changes that will take place during the event for 2019. Drs. Witzig and Kayumova shared their experiences and the curriculum they have developed for science workshops for the girls. The members of the audience shared their own experiences and questions about how to develop engaging STEM activities, so that, as a community, we can learn from each other.

Dr. Janet Kolodner's Visit to the Kaput Center

By: James Burke, Post-Doctoral Fellow

In 2018, exciting developments at the Kaput Center had us looking to the future of extending and deepening what learners know and can do in science and mathematics. With the approval of the new STEM Ed PhD program, one way we celebrated last fall was to welcome Dr. Janet Kolodner to speak on her efforts to inspire awe in STEM students. Dr. Kolodner is a pioneer in understanding how people learn from experience through her work on case-based reasoning. As she describes it, this approach tells us that "the better we can extract out connections between things in an experience, the better we'll be able to re-use what we learn." Applying this idea to problem-based learning, Dr. Kolodner and her colleagues found how sequences of classroom activities could allow middle school science students to succeed in challenging construction tasks while engaging in "science talk" to both justify and explain their work. Their findings emphasized the importance of a classroom ethos in which learning is a shared responsibility among all the participants – an understanding that influences mentoring in the Kaput Center CoderDojo today.

During her presentation to an eager audience of students, faculty, teachers, and community-members, Dr. Kolodner presented some of her work and thoughts on what middle school students learned in a multi-user virtual environment. The EcoMUVE project sought to determine what in the technology and classroom environment influenced students' learning while they engaged in scientific inquiry. Dr. Kolodner related a reaction she had to her work that, I wager, is familiar to many educational researchers. While she and her colleagues were addressing their research questions about what students remembered (their so-called "cold cognition" discoveries) there were even more interesting "hot cognition" discoveries to be made in the experiences that drew students in and made them "jump up and down" in excitement. EcoMUVE's support for the autonomy of students in exploration and purposeful inquiry proved to be an influential aspect in how students engaged in activities. The virtual environment's readily available tools and resources supported conjecturing, discovery, and then justifying discoveries to peers. Those affordances placed students in an empowered and exhilarating position of responsibility.

Dr. Kolodner's observations are a valuable and welcome reminder that our shared educational endeavor is also one of passion. As educators helping our students know and do more than ever before and as researchers working diligently to answer our most significant questions, there is something important in our students' joy. This is especially true when that joy stems from the authenticity of the experiences we offer, the autonomy that our students are afforded, and the wonder and awe students should feel when they accomplish goals of well-designed classroom activities.

CoderDojo Launched at the Kaput Center

By: Kimberly Welty, Grant Support Specialist

The Kaput Center launched its own CoderDojo on November 3rd, 2018. We had a full house (and a waiting list!) with 29 Ninjas (kids 7-17) attending sessions ranging from Scratch to Python and HTML. Chandra Orrill, Director of the Center, said the following when asked why she was inspired to create a Dojo "Each year, at our very successful STEM4Girls event, parents would ask me what else was available for their girls to do all year, and what opportunities existed for their boys? This club is our cost effective answer to both of those questions."

Scratch, an easy to use, block-based programming language, allows users to program interactive media such as stories, games, and animation. Scratch is designed and maintained by the Lifelong Kindergarten group at the MIT Media Lab.

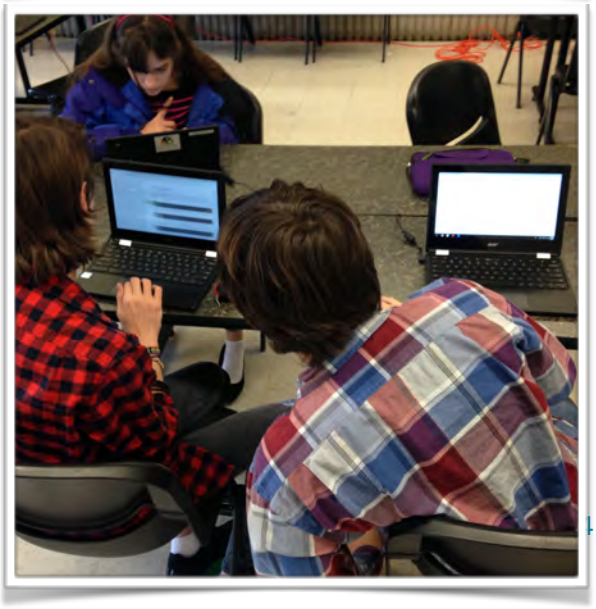
Python, one of the most popular and widely used open source programming languages, has an easy to read and write syntax which is used to create web development tools, games, scientific and networking programming. Ninjas are exposed to Python coding by using Pi-topCEEDs (Raspberry Pis), and Chromebooks.

The main aim of these sessions is to provide students an opportunity to engage with coding to create their own projects. The Center is planning to host a Dojo every first Saturday of the month, from 10am to noon on the UMass Dartmouth campus.

CoderDojo, an international organization based in Ireland, is made up of 58,000 Ninjas who are being creative with technology with the help of 12,000 volunteers in 109 countries.

Special Thanks to our Volunteer Mentors:

Dilshad Achilov, James Burke, Melissa Cieto, Meghan Denny, Tobey Eugenio, Paul Fredette, Tatyana Frost, Hamza Malik, Temple Mitchell, Chandra Orrill & Kym Welty



http://kaputcenter.org

Grant Spotlight: Making Proportions Fun

By: Chandra Orrill

As part of my NSF-funded Proportions Playground project, James Burke (Postdoctoral Fellow) and I travelled to deliver professional development to 22 teachers in December 2018 and Kym Welty joined us in a second offering for 15 more teachers in January 2019. The three-day professional development was focused on three big ideas: quantities, covariation, and constant relationships. The goal was to engage teachers in reasoning about proportional relationships. We built the curriculum for Proportions Playground around a set of values: playfulness, engagement, and exploration. To meet these values, we provided teachers with dynamic "toys" that let them make conjectures about the mathematics, then try those out. We saw in my previous project that engaging teachers in these computer-based environments really allowed them to try out ideas rather than rushing to find the answer. We built from work James had done in his dissertation about playfulness to try to create an environment in which the teachers felt safe to ask questions and explore mathematical ideas they might have been nervous about. To do this, we set some ground rules declaring our PD a judgement-free zone. We also wrote the tasks to really engage participants in discussion. We posed "mysteries" and "challenges" rather than giving them "math tasks" and we celebrated and explored disagreements. The teachers were thrilled with their experience giving use very high marks on their exit survey and stopped to thank us (and even hug us!) on their way out the door. We will use the data we collected to consider (a) how teachers interact with the Proportions Playground toys to reason about proportions; (b) what evidence there is of participants making connections in their own understandings' and (c) what evidence there is that Proportions Playground supports teachers in reasoning about proportional situations. The Proportions Playground toys are on the Kaput Center website: http://kaputcenter.org/proportions-playground please feel free to email me if you're interested in learning more (corrill@umassd.edu).

Upcoming Events

The Kaput Center is hosting an ISTE Teacher Certification course offered by Eduscape. The face-to-face portion of the course will be offered at the Kaput Center on March 14-15. The rest will be offered online. Get more info: bit.ly/fairhaveniste

Kaput Center
UMass Dartmouth

STEM-ester in Review

Kaput Center Newsletter

Welcome

We are excited to share our Spring 2019 Newsletter with you. Spring was busy – we hosted the largest-ever STEM4Girls event, went to a few local STEAM days, presented our research at a variety of conferences, and made plans for future endeavors. For this newsletter, we wanted to give everyone a flavor of STEM4Girls, so we are sharing articles from different perspectives about the event.

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

New People

The Kaput Center is delighted to welcome Ram Bala and Beth Cullen to our Executive Board. We look forward to our work together!

Participation doubled at 8th Annual STEM4Girls Day

By Kym Welty, Grant Support Specialist

On Saturday, March 30th, the Kaput Center held its 8th annual community outreach event called "STEM4Girls Day" at the University of Massachusetts Dartmouth. This free event was open to all girls in grades 3-8 who want to learn marabout and engage in Science, Technology, Engineering and Mathematics (STEM). This year, our participation doubled - nearly 250 girls from the SouthCoast area registered for the event, including students from Our Sisters' School and Irwin Jacobs Elementary in New Bedford, and Atlantis & Argosy Collegiate charter schools in Fall River. Our keynote speaker, Dean Jean VanderGheynst from UMass

Dartmouth's College of Engineering, shared her experiences in STEM with the audience, including what she loves most about her work - food sustainability. The keynote address was followed by a skit performed by a group of students from Our Sisters' School. The girls then attended STEM workshops, followed by lunch and an opportunity to play with Photons or (insert physics demo here). The event wrapped up with a guest panel of women working in STEM fields and a question & answer session. At one point, the lines on both sides of the auditorium to ask questions was 25 girls deep!

We hosted 23 STEM workshops (up from 16 last year) led by experts who volunteered their time. Presenters included UMassD faculty and graduate students from the College of Engineering, the School of Nursing, the School of Marine Science and Technology (SMAST) and the STEM Education and Teacher Development department. In addition, workshops were led by faculty from Tufts University and Stonehill College, local middle and high school teachers from Bourne, Dartmouth, Fairhaven and New Bedford, as well as people from other STEM organizations and industries. The success of our STEM4Girls day was made possible by the additional support of over 50 volunteers from UMassD faculty, staff and students, as well as community members who wanted to help.

Chandra Orrill, Director of the Kaput Center, was quoted as saying "We're introducing [the girls] to STEM ideas and giving them a good, positive experience on a college campus, and we're trying to empower to show them women can work in STEM fields….We want them to accomplish feeling like there's a place in STEM for them." Orrill concluded "We hope they learned a bit about STEM, but we really wanted them to leave feeling like they can do this and know it's really exciting."

Randomness at STEM4Girls Day

By: James Burke, Post Doctoral Fellow

Year after year, STEM4Girls is a rewarding experience and unique opportunity for STEM educators and practitioners to share powerful, fun ideas and activities with an enthusiastic and engaged group of middle and elementary school girls. This year, an exceptional number of girls attended. Several buildings at UMassDartmouth came alive with young women solving problems, thinking mathematically, asking questions and seeing how they could use and build technology.

In the workshop I designed and led, girls considered the question: "What is random?" Girls offered great definitions from their own experiences: random is weird, random is unexpected, random is freckles, random is…just, you know – random!

We discussed formal mathematical definitions of randomness, while the girls experimented with choosing random numbers vs. rolling random numbers on dice with different numbers of

sides. Then the girls applied a computer language "random" function on a tiny Micro:Bit device to simulate the "Magic 8 Ball" fortune telling toy, but with their own customized responses.

As we finished up the workshop, we were able to connect randomness back to one of the girls' definitions. Randomness is used in motion pictures to create natural looking freckles on the skin of computer generated characters. The girls found that, in randomness, mathematics is yet another part of their world.

Inside Look: STEM4Girls from a volunteer's perspective

By: Akira Harper, Doctoral Student

My name is Akira Harper, and I am a first-year doctoral student in the STEM Education program at UMass Dartmouth, and I had the privilege of volunteering at STEM4Girls. The focus of this annual event is to empower girls, starting at a young age, and shift the narrative of who can be successful in the STEM fields. The volunteers included annual event planners, like Chandra Orrill, guest speakers, teachers in the community and students at the University.

My role as a volunteer was to assist in the science room where students were exposed to learning about live animals. In our classroom, these girls got to learn about and play with crabs, hermit crabs, whale teeth and more! As a volunteer, I was fortunate enough to connect with these girls and share my story, as most of the girls who participated in the event came from the same background as I did. As a minority who comes from a non-affluent single-parent household, being a doctoral student in STEM, I am not the image that these students are typically exposed to. Being able to discuss topics that revolved around STEM over lunch and interact with STEM toys, like the Photon Robots (where students are introduced to entry level coding) made learning about STEM a more interesting and positive experience for myself and the girls included.

Dr. Kristy Daniel shares research experiences on representational competence with interdisciplinary Kaput Center audience

By Stephen Witzig, Associate Professor

On April 19, Dr. Kristy Daniel, Associate Professor of Biology from Texas State University, visited the Kaput Center for a research talk focusing on how scientists communicate their work in ways that makes science accessible. Dr. Daniel works from a framework of representational competence, which she has recently published in an edited book with Springer (Daniel, 2018), *Towards a Framework of Representation Competence*. This framework focuses on how people use and interpret visual diagrams to share understandings about science concepts.

During her visit, she met in small groups with Biology faculty and doctoral students, as well as STEM Education faculty and doctoral students – disciplines that she seamlessly navigates between as a biology educator. When meeting with Biology doctoral students, she noted how she was able to develop new collaborations connected to her research agenda, "I was able to introduce her [a doctoral student in Biology] to one of my current doctoral students in Texas. The two of them shared several interests and are planning on working together to collect data from Boston that will help inform a science communication project on which we are currently working." Much of her interactions while on campus were with students in the PhD program in STEM Education. Dr. Daniel shared, "I think the STEM Education doctoral students at UMass Dartmouth are fortunate to be able to have such a supportive and dedicated cohort to help them through the doctoral journey. These students demonstrated loads of potential as science educators and I wish them all the best."

Dr. Daniel's seminar drew a truly interdisciplinary audience, including faculty and students from programs in STEM Education, Biology, Physics, Engineering, and Mathematics. "I found it rewarding to speak to a diverse group of researchers that were clearly engaged with thinking about ways we can push knowledge boundaries and expand how we typically think about science education and communication" Dr. Daniel noted, adding, "I loved the interactive nature of the Kaput Center seminar. People asked thoughtful questions that promoted deeper thinking and interesting discussions about the topic at hand." The Kaput Center colloquium series was designed to be both interdisciplinary and interactive, so it was encouraging that these aspects stood out to Dr. Daniel during her visit.

For more information on Kaput Center colloquium series, email kaputcenter@umassd.edu, or visit http://kaputcenter.org/events/.

Do Black Women and Girls Belong in Mathematics? A Colloquium by Dr. Nicole Joseph

By: Chandra Orrill

On May 6th, the Kaput Center hosted Dr. Nicole Joseph a mathematics educator from Vanderbilt University. Dr. Joseph spent the day making new connections with faculty and doctoral students in the Kaput Center, and then presented on her research. Her presentation, I DO (NOT) Belong: Experiences of Black Women and Girls in Mathematics Education challenged the audience to think about why Black girls may or may not go into mathematics as a career path.

In her interactive presentation, Dr. Joseph asked the audience to review data about Mathematical Sciences Doctorates conferred since 2004. The data, from the National Science Foundation, showed that while between 508 and 948 Ph.D.'s were conferred nationwide, less than 1/3 of those were earned by women of any background, and 2% or fewer were earned by Black women.

To these sobering statistics, Dr. Joseph added quotes from Black women from several research studies conducted by herself and others about Black women in STEM fields. The quotes paint a picture of isolation and frustration, as well as highlighting the burden the women feel because they perceive that if they fail, their failure will be seen by others as their entire race failing. The audience discussed these ideas in small groups and as a whole group.

Dr. Joseph ended the session on a high note showing the audience a slide filled with photos of Black women who are rising stars or who paved the way for others. We appreciate Dr. Joseph helping us identify the hurdles Black women face and challenging us to be better.

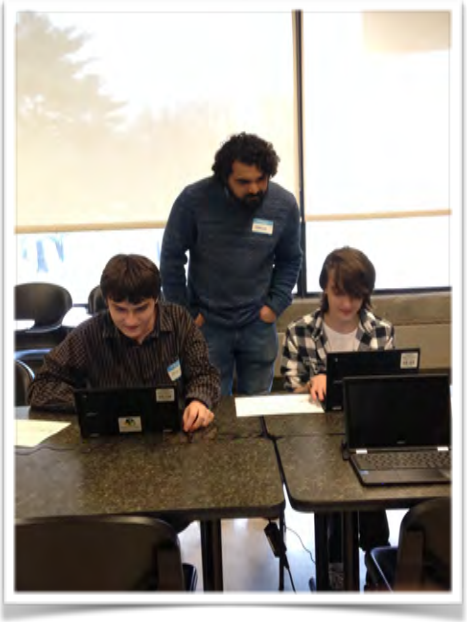
For more information on Kaput Center colloquium series, email kaputcenter@umassd.edu, or visit http://kaputcenter.org/events/.

SouthCoast@ KaputCenter CoderDojo continues through the summertime

By: Hamza Malik, Doctoral Student

CoderDojo, an international organization based in Ireland, is made up of 58,000 Ninjas who are being creative with technology with the help of 12,000 volunteers in 109 countries. It is a global movement led by volunteers to organize a community-based programming club for young people. The Kaput center launched its own CoderDojo chapter on November 3rd, 2018 with an objective of providing opportunities for students to learn and explore coding in an informal, creative and social environment. The main aim of these sessions is to provide students an opportunity to engage with coding to create their own projects and/or explore different coding languages. The Center hosts a Dojo every first Saturday of the month, from 10 am to noon on the UMass Dartmouth campus since its inception from November 2018 and to date, we have hosted 67 students in total, nearly half of whom have come back more than once.

I work as a mentor with South Coast @ Kaput Center-UMass Dartmouth CoderDojo and my role is to help students learn to code using Python. During the session, students get a chance to code in different languages as well such as Scratch, Python, and HTML. Students are encouraged to follow three simple sets of rules; One rule for kids: be cool, ask three then me and if you made it, you can play it. These sessions not only help the students in learning to code, but they also helped me as a mentor to understand how kids come up with out of the box and creative ideas when it comes to computer coding if given an opportunity such as CoderDojo sessions.



Special Thanks to our Volunteer Mentors this spring: *James Burke, Melissa Cieto, Tobey Eugenio, Paul Fredette, Tatyana Frost, Krushita Kothari, Miraj Mahmood, Hamza Malik, Temple Mitchell, Chandra Orrill & Kym Welty*

Girl Power in Making Presentation to Multidisciplinary Seed Fund Program

By: Charlemya Erasme, Doctoral Student

On April 29th, members of our *STEAM Language, Learning and Identity* research lab, led by Dr.Shakhnoza Kayumova (Kaput Center Research Scientist), UMassDartmouth administrators, and faculty (including Dr. Walter Stroup, Kaput Center Research Scientist) presented *Girl Power in Making: Understanding Trajectories of Identification with STEM Disciplines Among Diverse Adolescent Girls in Making, Coding, and Robotics Infused Science Classes* to the Multidisciplinary Seed Funding (MSF) Program. The Girl Power in Making research project is dedicated to understanding the positive science identity development of bilingual and multilingual youth, particularly at-risk girls, by examining their perceptions about science, who can or cannot do science; learning by making STEM curriculum approaches & norms of interaction that either support or hinder girls' full participation in STEM curriculum. The presentation discussed the project's objectives and goals, outlined preliminary findings and introduced areas for future research. We offered counter narratives to deficit perspectives that often surround minority youth regarding their ability to participate in STEM subjects. Our research showed that students, when given access to robust STEM through instructors & instruction; curriculum; tools; peers or on their own took on complex and robust identities. Special thank you to all those involved and to the MSF program!

STEAM Language, Learning, and Identity

Research Lab

Research Activity

While much of our newsletter is dedicated to our outreach and education activities, the Kaput Center remains a thriving research center. In 2018-2019, our research scientists published 21 papers. Take a look at the list below and see what might be of interest to you! (Note: Research scientist's names are in bold)

Bazzul J., & **Kayumova, S.** (2018). The ethical subject of science education: Toward different ethico-politico frontiers for twenty-first century science education. In Reis G., Mueller M., Gisewhite R., Siveres L., Brito R. (Eds.), *Sociocultural perspectives on youth ethical consumerism. Cultural Studies of Science Education* (pp. 101-114). Springer: Dorecht, Netherlands. https://doi.org/10.1007/978-3-319-65608-3_7

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, Switzerland..

Brady, C. E., **Stroup, W. M.**, Petrosino, A. J., & Wilensky, U. (2018, August). Group-based simulation and modelling: technological supports for social constructionism. Presented at *Constructionism Conference*, Vilnius, Lithuania

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 I*nternational 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.

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Have a great summer!

We are looking forward to Fall 2019 when we hope to engage in even more outreach, including creating a hands-on event for teachers to try out technologies they may not have seen before, improving our CoderDojo, and continuing our efforts to reach across campus to create an interdisciplinary research and outreach center.