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 FY11.
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Annual Report Series No. 4
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, Public Policy and Civic Engagement.

**Stephen J. Hegedus, Ph.D.**
Director

**EXECUTIVE BOARD AS AT END OF FY11**

<table>
<thead>
<tr>
<th>Name</th>
<th>Role and Affiliation</th>
<th>Term Expires</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dona Apple, M.S.</td>
<td>Senior Consultant for Research &amp; Staff Development, UMass Dartmouth</td>
<td>05/13</td>
</tr>
<tr>
<td>Brenda Berube, M.S.</td>
<td>Research Scientist/Associate Professor of Science and Science Education, UMass Dartmouth</td>
<td>08/11</td>
</tr>
<tr>
<td>Maria L. Blanton, Ph.D.</td>
<td>Senior Research Scientist/Professor of Mathematics Education, UMass Dartmouth</td>
<td></td>
</tr>
<tr>
<td>Marylou T. Clarke, C.A.G.S.</td>
<td>Assistant Superintendent of Dartmouth Public Schools (Retired)</td>
<td>05/11</td>
</tr>
<tr>
<td>Marjorie Condon, Ph.D.</td>
<td>Curriculum Director, Westport Community School District</td>
<td>05/13</td>
</tr>
<tr>
<td>Michael Goodman, Ph.D.</td>
<td>Associate Professor of Public Policy, UMass Dartmouth</td>
<td>08/12</td>
</tr>
<tr>
<td>Edward Lambert, M.Ed.</td>
<td>Director, The Urban Initiative, UMass Dartmouth</td>
<td>05/12</td>
</tr>
<tr>
<td>Luis Moreno-Armella, Ph.D.</td>
<td>Senior Research Scientist/Professor of Mathematics Education, Cinvestav</td>
<td></td>
</tr>
<tr>
<td>Rebecca L. Moniz, B.A.</td>
<td>Research Associate/Project Manager, UMass Dartmouth</td>
<td>05/13</td>
</tr>
<tr>
<td>Chandra Orrill, Ph.D.</td>
<td>Research Scientist/Assistant Professor of Mathematics Education, UMass Dartmouth</td>
<td>05/13</td>
</tr>
<tr>
<td>Louis Petrovic, Ph.D.</td>
<td>Director, Advanced Technology &amp; Manufacturing Center, UMass Dartmouth</td>
<td>05/13</td>
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<tr>
<td>Ismael Ramirez-Soto, Ed.D.</td>
<td>Dean, School of Education, Public Policy &amp; Civic Engagement, UMass Dartmouth</td>
<td></td>
</tr>
<tr>
<td>John Russell, Ph.D.</td>
<td>Emeritus Professor of Physics, UMass Dartmouth</td>
<td>05/12</td>
</tr>
<tr>
<td>Bal Ram Singh, Ph.D.</td>
<td>Director of Botulinum Research Center &amp; Center for Indic Studies, UMass Dartmouth</td>
<td>08/11</td>
</tr>
<tr>
<td>{Empty Seat}</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Correspondence and inquiries should be addressed to: Kaput Center for Research and Innovation in STEM Education, University of Massachusetts Dartmouth, 200 Mill Rd., Suite 150B, Fairhaven, MA 02719 (telephone: 774-929-3065; fax: 508-999-9215; email: kaputcenter@umassd.edu).
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 mathematics 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 mathematics 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 2010 to June 30th 2011, which is Fiscal Year 2011. This document was prepared by Dr Stephen Hegedus, Director of the Center, and presented to the Kaput Center Executive Board on August 24th 2011.
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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.

President Jack Wilson approved its establishment on February 14th 2007 and it 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.

This report documents the ongoing work of the Kaput Center through FY2011 and new initiatives.
Director’s End-of-Year Report FY2011

The end-of-year report for FY2011 reflects growth and productivity that is closely aligned with the vision and mission of the Kaput Center. I am thankful to faculty, staff, students, research scientists and associates, advisors, and the executive board for making this happen. I am truly grateful and honored to be around so many hard-working, creative thinkers that make the Kaput Center a reality.

My vision for the Kaput Center is for it to always be an international and open organization that has no walls and operates by a central principle of “democratizing access to all students.” Whilst there are physical walls here at our headquarters in Massachusetts, this is a fixed geographical place to centralize operations. Our work extends beyond here, in the minds and hearts of the associates at many locations, both close by and further afield. The Center aims to be a public higher education institution that publicizes its work freely. Our yearly reports are available online which aim to ensure transparency in our work and related financial matters. The Center further opens its “doors” through streaming our various events and talks on-line. We also publish our talks on-line for people farther afield to watch them at their leisure and this has been a great intellectual asset back to the community at large. The Internet and many Web 2.0 tools allow us to do this and to operate for the public.

My continuing vision is to broaden our impact by promoting the work of our associates and to be more personable. Our webpages should not only serve as an archive of events and products but also be personal. This year I aim to implement more mini-promotions or nano-lectures of the work of the Center’s associates locally and around the world. It is so easy to share video stories through our home page and YouTube now. I also hope that more people will befriend our Facebook account to react and talk about these video stories.

For me, a Center should have a home but its members should be diffuse. Its identity is its members. I have difficulties with words such as “executive” in a public academic context, but I aim to continue to work for its members and value our executive board in helping and guiding me in being true to this aim. I do see the Center as a community of like-minded people who believe in the democratizing principle across many groups and technologies that create access. To quote John Henry Clippinger: “There is no such thing as the noble savage, we are a crowd of one.” We create an identity by our collective identity, by knowing each other’s strengths, by working together and by naturally promoting leaders within that organization. That said I believe that the functionality of a Center and its operations can be likened to a corporation. It is entrepreneurial. It seeks to produce things. Its profit is in the generation of new
ideas, knowledge, practices and products. It is run by money. I am a fund-raiser but then at the same time I am not the only fund-raiser. The institution where the Kaput Center is housed can also advocate for more funding through endorsement of our work. Without good publicity and public relations as an infrastructural piece, we cannot operate. In the space of a global economic crisis, and a generation of new children that do not necessarily understand why they need school, and educational policy that has been mandated from the top, the space for basic, let alone applied, research here is becoming smaller and smaller. New policies, a general lack of funding, much political talk around STEM education, and the potential disaster of a workforce without any graduates in math and science, is sucking the air out of the room and not giving us breathing space to promote our work. Our work is based upon sound principles, decades of research, rigorous methodologies, and solid evaluation that points to certain conditions in schools and classrooms where effect can occur. This needs to receive wider attention and endorsement. I believe our nation is not necessarily at risk as it is a nation of innovation. It needs to turn its attention to believing in Centers of Excellence, and endorsing them where substantive evaluation has occurred. We should be a data-driven enterprise but unfortunately some of my own projects have suffered where schools cannot always provide data about their students. We need to explore how partnerships with schools can be improved in order for us to receive the vital data we need to investigate change over time.

I have been criticized that the Kaput Center could have more impact and could be promoting its work by translating the many well-funded research projects into practice. I appreciate this criticism but I believe it is our collective responsibility to be advocates of the work not just our own individual work. The executive board, its associates, and UMass in general should be evangelists advocating the good work we do here, seeking ways to communicate this work to various power-brokers and stake-holders. We should all be seeking endorsement. Nevertheless, I will continue this Fall to meet with various people and seek endorsement through legislative breakfasts and meetings with school boards.

To begin to address this aim, this Fall, I will be releasing an on-line portal, “Kaput On-Line,” that aims to offer services to support training in using various products that my associates here and at other places have created. We will begin with SimCalc, a mature educational research product, partly commercialized following 15 years of R&D, as well as Model-Eliciting Activities in STEM by my colleagues at other universities. We will begin with stand-alone tutorials for teachers and curriculum developers to watch and assess how we can further offer live training sessions on-line through various services in the future. We will also disseminate our SimCalc curriculum materials and instruments for free and
offer web functionality for new users to share their classroom experiences and for educational researchers to present pre-publication findings.

I have faith that this will work but I continue to seek advice on how this can be improved. I wish to conclude with a summary of the great work of my associates this year.

The Kaput Center now has:

- 100 members on its interdisciplinary advisory board from various countries and academic backgrounds
- 41 research scientists/associates
- A 14-member executive board

We have hosted many international visitors this year as well as PhD students and undergraduates under Noyce scholarships.

We had 11 speakers in our interdisciplinary colloquium series, which were well received and attended. This year these talks also comprised a seminar for our PhD students.

We hosted 4 Workshops/Roundtables on issues around STEM education, new curriculum and contemporary issues such as Common Core Standards. These events had between 20-50 attendees and one was co-hosted with the STEM Regional Network.

We hosted an enrichment program in math and science for 150 local girls aged 11-15 in collaboration with the Greenlight for Girls organization. This was a huge success and one we aim to repeat next year with more girls. By the end of the event, many girls expressed an interest in studying mathematics or science at university.

The Center continues to be productive in submitting grant proposals to various agencies as well as being successful in receiving funding. More details are included in this report.

Next year, I want to focus on impact and I look forward to discussing, with a wide variety of people, what this means and what the Kaput Center can specifically do. I would like to host an academic summit for teachers and educators where they can interact with educational researchers, and discuss how to best translate our work into classrooms. In addition, we will engage in discussion and debate about important changes in our state, such as the Common Core Standards. We also have a stellar cast of speakers from various disciplines to inspire us to think in diverse ways.
I am looking forward to the next year and the hard work ahead, and am excited to continue to direct the Kaput Center in an even more effective way.

Stephen J Hegedus, PhD
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 or a qualified professional practitioner with a documented record of scholarship or professional experience in education or educational policy, particularly, but not constrained to, mathematics education research. The Director invites and accepts nominations for members of the Executive Board for review by the Executive Board.

The Executive Board exists to assist the Director and Associates of the Center in fulfilling the goals of the Mission. They are expected to advise the Director on the strategic agenda of the Center because of their expertise in matters of research, community outreach, professional development and higher education in general.

The Executive Board convenes quarterly by the Director of the Kaput Center. The Director of the Kaput Center must notify all members of the Executive Board of the time, date, and place of all quarterly meetings at least one week prior to said meetings. A simple majority of the Executive Board shall constitute a quorum. Meetings are run subject to Robert’s Rules of Order. The Provost and the Chancellor of the University of Massachusetts Dartmouth 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 Senior Research Scientists, Research Scientists, and 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 reject the establishment and termination of research publications that are longitudinal in nature,
• to approve or reject the Director’s recommendations for a standardized schedule of fees and charges for labor, photocopying, document sales, and other services,
• 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, and
• 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 two (2) years and renewable.

During FY11, Robert McCabe, Emeritus Professor of Physics at UMass Dartmouth stepped down from the Board after nearly 4 years of service.

Dr Michael Goodman, Associate Professor of Public Policy at UMass Dartmouth and Dr Chandra Orrill, Assistant Professor of Mathematics Education at UMass Dartmouth joined the board.

One seat remains open on the Board and we are seeking to fill it early in FY12.

**Advisory Board & Duties**

The Kaput Center is linked to the wider community through an Advisory Board. The Advisory Board is 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 mathematics education. The members of the Advisory Board are considered advocates of the Center, promoting the work of the Center and establishing new associations with leaders in mathematics education research and innovation.
During FY11, there were 100 members on the Advisory Board. It should be noted that each person accepted and was honored to be elected to the Board. The Advisory Board has 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.

A full list of advisors can be found in Appendix B and on-line at: http://www.kaputcenter.umassd.edu/associates/ab/

**Research Scientists, Associates & Staff**

During FY09 certain titles were revised. There are no longer any executive titles. The title of Research Associate (for Kaput Center staff) and Research Assistant (for Kaput Center students) were kept. The titles of Research Scientist, Senior Research Scientist and adjunct versions of these were created for faculty and staff leading projects and collaborating closely with the Kaput Center. The Director nominates these positions to the Executive Board.

At the end of FY11 there were 12 Senior Research Scientists, 20 Research Scientists, 6 research associates, and 3 research assistants. We will continue to build our core faculty and staff and adjunct scientists in FY12 in establishing new projects and providing a rich and diverse environment for students in the PhD in Mathematics Education, which the Center closely supports.

**Physical Layout & Equipment**

The Kaput Center occupies approximately 3000 square feet at a rented facility in Fairhaven, MA, 8 miles from the main Dartmouth Campus. The Center is split between a main resource room, a 20-person conference room, a library, and office space. See Figure 1 for a floor plan.
The Center is a high-fidelity research facility with a high-tech physical infrastructure largely funded by research grants from external agencies, the Director's Indirect accounts and start-up funds from UMass Dartmouth. These include:

- High-speed connectivity to the Internet and a secure pipeline to Campus e-resources via hardware VPN (as if we were on campus)
- Gigabit connectivity within the Center and secure 802.11a/b/g/n wireless connectivity
- Video-Conferencing/audio casting equipment incorporating the UMass Wimba service
- Blog and podcasting via an XServe Mac OS 10.5 Leopard Server
- DVI/VGA video projection with podium facilities
- Ceiling mounted projectors + HD/DVI Document Cameras (video recording available)
- 66-inch rear projection SmartBoard with connection to the Internet & Public Wiki
- 20-computer Apple Wireless Learning Lab with Apple and Windows OS and a suite of mathematical and mathematics educational software (e.g., Mathematica, Maple, Matlab, SPSS, Geometer's Sketchpad®, Cabri, MS Office, Adobe, Macromedia, etc.)
- HDTV + HD equipment for high quality broadcasting and presentation
- HD/DV cameras
- High speed digital video processing machines with large screen displays (Mac)
- Part-ownership of the SAN Campus backbone system (safe and reliable back up of server side resources including web and database administration)
- Public and Private Wiki sites and other digital software to manage projects and e-portfolios
- On-line secure databases and data-mining facilities including quantitative and qualitative software (e.g., SPSS, HLM6, nVivo)

In addition, the Kaput Center has a terabyte server of multi-media data from several projects and teaching experiments that are digitally available under a secure network at the Center. All materials are signed and protected and permission to use such materials is obtained via the Center Director under IRB requirements.

Our 8-core terabyte XServe allows users to create workflows from digital cameras, either directly or after recording an event, straight to a Podcast or Blog, completely automating the video process and publishing procedure. This is especially useful for PhD students wishing to record classrooms or events at the Center.

In addition to these technical facilities, the Kaput Center has a large library that supplements the Campus library facility and which includes many Math Ed 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. In addition, the Center stocks the majority of wide-readership journals including Nature, Science, and The Economist, to name a few. 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 (over $20K worth of major Handbooks in this category alone). In addition, the resource room has a wide selection of K-16 mathematics curriculum.

A full list of journals stocked within the Kaput Center library can be found in Appendix A.
**Inventory**

The Center has a wide range of resources to conduct the work necessary to achieve the goals of its mission. In summary, these include:

- Conducting funded and unfunded (proof-of-concept) research and development programs,
- Provide professional development services (both on-site and on-line) and,
- Host various professional meetings and events throughout the year.

The Center has total capital assets and related service plans of $282,948. Table 1 summarizes areas of assets.

<table>
<thead>
<tr>
<th>Type</th>
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<tbody>
<tr>
<td>Furniture</td>
<td>$61,161</td>
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<td>Office Supplies/Decorations</td>
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<td>Appliances</td>
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<td>AV Equipment</td>
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<td>Office Equipment</td>
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<td>Computer Equipment</td>
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<td>Cables/Adapters</td>
<td>$2,544</td>
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<td>Service Plans</td>
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</table>

Table 1: Main Areas of Assets

**Summary of Fiscal Activity**

Table 2 below presents the revenues and costs of the Center during FY11. In addition to these accounts are revenues and expenditures related to externally funded research projects that faculty within the Center are principle investigators. Total revenue for FY11 was $2,857,508 ($83,786 from the University, $2,714,810 from grants (which includes recovered indirect funds), $20,500 from contracts, $3,000 from donations and $35,412 from carry-forwards from accounts) with associated direct costs of $1,473,440 (the majority of remaining revenue is encumbered grant funds).

The steady increase in revenue into the Center since its inception is noteworthy and is illustrated in Figure 2 below. The majority of this income comes from external grants. There was a steep increase in funds to $2.75m this year.
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 FY11 was $83,830 with operational expenses of $85,053.

Figure 2: Research Revenue FY2007-2011
<table>
<thead>
<tr>
<th>Expense Type</th>
<th>Description</th>
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<tbody>
<tr>
<td>Revenue</td>
<td>University Support (Salaries, Fringe, &amp; Operational Budget)</td>
<td>$83,786</td>
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<td>Carry-forward FY09 (Operational budget &amp; other)</td>
<td>$44</td>
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<td>Total Revenue</td>
<td>$83,830</td>
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<td>Direct Expenses</td>
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<td>Payroll</td>
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<td>Fringe</td>
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<td>Total Payroll &amp; Fringe for FY10</td>
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<td>Non-Payroll</td>
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<td>Non-Employee Travel</td>
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<td>Total Non-Payroll</td>
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<td>Total Direct Expenses</td>
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<td>Remaining Balance (excluding recovered indirect costs)</td>
<td>-$1,224</td>
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Table 2: Revenue & Costs for FY11
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:

- Early Algebra
- Touching, feeling and seeing mathematics and science ideas through new technologies
- Transforming communication & expression with wireless connectivity—aspects of participation, motivation & identity
- The development of proof and reasoning across the grades K-16
- Transforming teaching practice across districts
- Teacher knowledge and teacher professional development
- District-wide improvement of mathematics and science teaching in elementary and middle grades
- International Studies

The mission of the SimCalc program is to “democratize access to the mathematics of change and variation.” The main software product of the SimCalc program is called SimCalc MathWorlds® and is available at http://kaputcenter.umassd.edu/. SimCalc supports learning about rate and accumulation by connecting students’ experience of animated motion to mathematical functions, which are portrayed in algebraic, graphical, verbal and tabular representations. The SimCalc research program and its software have been evolving over more than a decade of research, spanning at least 8 major funded research projects.

The SimCalc Learning and Motivation Project (LAMP) incorporates the use of wireless technology from Texas Instruments, and integrates activity structures into high school algebra classrooms. The present project (completing Year 4 of 4 in FY11) is funded by the US Department of Education, Institute of Education Sciences, and is a longitudinal efficacy study measuring impact on student learning and motivation to learn over time. (See http://www.kaputcenter.umassd.edu/products/technical_reports/)

The central goal of the Early Algebra Project, recently funded by the National Science Foundation is to understand (1) how young children reason algebraically, the ways in which they express their reasoning and how these
forms of reasoning evolve in their thinking and (2) how teachers’ learning of mathematics and teaching evolves as they incorporate algebraic thinking into their daily classroom practices. It has led to important insights on teaching and learning algebraic ideas in the elementary grades. See, e.g., *Algebra in the Early Grades* (Kaput, Carraher & Blanton, 2008) and *Algebra and the Elementary Classroom: Transforming Thinking, Transforming Practice* (Blanton, 2008) that sets the stage for exploring the impact of students’ understanding of algebra as they transition through and beyond elementary grades.

The *Scaling Up SimCalc research project* (led by Jeremy Roschelle of SRI International) investigated, through a randomized experiment, whether a wide variety of teachers could use SimCalc to support their students’ learning of conceptually complex mathematics in 7th and 8th grade classrooms in TX. The Kaput Center has been a major partner on this project. (See [http://math.sri.com](http://math.sri.com)). Last year we completed a diffusion study of what factors lead to teachers sticking with and/or spreading SimCalc resources.

The *Proof Project*, a National Science Foundation ROLE Project, uses a sociocultural lens on teaching and learning to explore the development of undergraduate students’ thinking about proof and how classroom practice can support this. As part of this, through symposia designed to bring together scholars whose work looks at proof across grades K-16, the project has sought to articulate how different forms of proof and argumentation evolve in students’ thinking across the grades and the curricular and instructional issues associated with a K-16 approach to teaching and learning proof. See *Teaching and Learning Proof Across the Grades: A K-16 Perspective* (Stylianou, Blanton, & Knuth, 2009)

The *Haptics Project*. This was recently funded in June 2009 by the REESE division of the National Science Foundation. We are aiming to investigate the impact of integrating haptic “force-feedback” devices with Geometer’s Sketchpad and analyzing the impact on students’ understanding of conceptually-rich mathematical and scientific ideas in elementary and undergraduate classrooms.

The *Does it Work?* Project. This is funded by the REESE division of the National Science Foundation. The project concentrates on the InterMath-Number Concepts course, a 50-hour course aimed at developing teacher content knowledge about numbers. The project studies 4 implementations of the course that were offered to 6th and 7th grade teachers. The proposed work is vital for improving educational opportunities for mathematics learners. Growing bodies of evidence show that professional development can have a positive effect on teacher knowledge and that teacher content knowledge is positively correlated to student achievement. This project will collect an extensive body
of data with which to gain insight into the links between professional development, teacher learning, and teacher practice and student achievement.

**The Diagnosing Teachers’ Multiplicative Reasoning (DTMR) Project.** This is funded by the DR-K12 division of the National Science Foundation. It is an exploratory project that addresses the assessment component of the KR-K12 Contextual Challenges strand. The project will develop and evaluate a test form that diagnoses teachers’ capacities in two closely connected cases of reasoning about multiplicative relations among quantities. The first has to do with measurement that often relies on multiplicatively nested levels of units when partitioning a given quantity. The second has to do with covariation that often relies on multiplicative relations between distinct quantities. The project will focus on aspects of such reasoning that are interconnected and fundamental to addition and subtraction of quantities, multiplication of quantities, quotative and partitive division of quantities, and ratios of quantities. We will consider fractions, decimals, and ratios. A main goal of the project is to address content and construct validity of the demonstration form in sufficient depth so that larger scale work and predictive validity studies may follow.

**CAREER: Coherence as a Basis for Understanding Teachers’ Mathematical Knowledge for Teaching Project.** This project is recently funded by the National Science Foundation in April 2011. This project aims to explore a hypothesis about mathematics teacher knowledge formed through work with teachers both in research settings and professional development. The hypothesis is that being a good mathematics teacher requires not only developing a certain body of knowledge, but also having mapped that content into a coherent and connected understanding of the domain that includes insights into what the content being taught grows out of and where it goes next. This project will focus specifically on middle grades teachers’ knowledge of proportional reasoning. A mixed methods approach will be used in the first phase to develop profiles of understanding that highlight not only the body of knowledge teachers have developed, but also the connections among facets of that knowledge. Once those profiles are complete, phase 2 will focus on looking at teachers’ practice to develop interconnected profiles of understanding that consider not only the ways in which teachers understand the domain, but also how those interconnected understanding manifest themselves in the classroom. The hypothesis is that teachers with more connections in their understanding will have more tools to draw upon in their classroom teaching, thus using their knowledge in different ways from teachers with a less coherent understanding.
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 ...

The Center features prominent speakers from multiple fields in its monthly colloquium series.

This year 11 speakers were invited (6 in the Fall semester & 5 in the Spring semester) to present on their research and perspectives of creativity & innovation that reached across disciplines. Each talk led to rich and open-ended discussion. A streaming video of each talk and associated materials can be found at the Center’s website (http://www.kaputcenter.umassd.edu/events/cs/10-11/).

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

How is Creativity in Schools? Remarks on Intimacy, Identity & Motivation
Stephen Hegedus, University of Massachusetts Dartmouth

The Forensic Science Crime Lab: CSI & URI
Dennis Hilliard, URI & the Rhode Island Crime Lab

Perceiving & Conceiving in Mathematics & Science
Robert Goldstone & Richard Lesh, Indiana University Bloomington

Data Games
William Finzer, KCP Technologies & Cliff Konold, University of Massachusetts Amherst

What Babies and Little Kids Tell Us About Algebra (Even for Big Kids)
Paul Goldenberg, Educational Development Center (EDC)

Stars in the Classroom: Teaching Geometry Through Islamic Art
Pamela Karimi, University of Massachusetts Dartmouth

What Do Career Education, STEM Education, and Policy Have in Common?
Mike Barnett, Boston University

Design, Research, and Design-based Research Methods: How Can We Improve and Study How People Live and Learning with Their Technology?
Chris Hoadley, New York University
Designers Speak: Challenges in US Mathematics Education Through a Curriculum Developers Lens
Glenda Lappan, Michigan State University

This year we used the university’s on-line streaming service for all of the lectures and integrated our new Blog site so that speakers could interact with their audience. See http://kaputcenter.blogs.umassd.edu/

Greenlight for Girls Day SouthCoast (June 11th 2011)
On Saturday, June 11th 2011, the Kaput Center, in partnership with Greenlight for Girls (http://www.greenlightforgirls.org), hosted an all-day FREE event at the University of Massachusetts Dartmouth for over 130 girls ages 11-15 years old to learn about Science and Technology. The girls attended 3 out of a possible 16 hands-on workshops related to topics in the fields of Science, Health & Beauty, Oceanography and Engineering. Workshop presenters came from various organizations/institutions, including, UMass Dartmouth, Lockheed Martin, NUWC (Naval Undersea Warfare Center), Global Learning Charter School, New Bedford Ocean Explorium, University of Albany & URI Graduate School of Oceanography.

K-20 Regional STEM Partnership
This evolving network reached out to a wider variety of stakeholders this year. In addition to mathematics educators we contacted teachers in all STEM disciplines, the region’s K-12 administration as well as local business leaders and legislators. Our aims and objectives focus on:

- To provide a forum for teachers, school and business leaders, and state elected officials to share with each other successful initiatives and resources used to improve STEM education
- To build community so teachers can support and provide opportunities to other teachers/schools who are in need
- To discuss the future of education in our region and how we can better serve our students
- To inform the University of what they can do to develop research and development programs to create necessary change.
This year we focused our efforts on specific workshops or roundtables reflecting and critiquing contemporary issues (e.g., Common Core Standards) and next steps as a partnership. Below is the list of provided workshops/roundtables:

“Reactions & Reflections to MA STEM Initiatives & Common Core Standards”
Anthony Sapienza, David Cedrone, Barbara Libby, Mark Whalen, Ismael Ramirez-Soto
This roundtable event involved individuals from education, business and government. They discussed issues related to MA STEM Initiatives and the Common Core Standards.

“STEM Literacy Standards”
Katherine Honey, Viki Bartolini, Kathryn Dunlap, Kaput Center
This workshop event discussed how to integrate literacy into math and science classrooms.

“Connecting K-12 STEM to Higher Education”
Various speakers from the CONNECT Colleges
This event was held in collaboration with SE/Cape and Islands STEM Network. Representatives from local CONNECT higher education institutions discussed their STEM Initiatives and specific programs for which they are soliciting K-12 participation.

“Creativity in K-8 Classrooms Standards”
Maria Blanton & Michael Looney
This workshop focused on how to connect curriculum within the elementary grades and how one can integrate new technologies into K-8 classrooms.

We have connected with over 30 districts as illustrated on the map below:
Licensing & Commercialization

SimCalc MathWorlds® is now a registered trademark of the Board of Trustees, University of Massachusetts.

SimCalc MathWorlds® software for calculators and computers is a licensed product. We have sold several licenses this year to various institutions around the world. Our aim is to create a community of users who are equally concerned with improving learning and motivation in a wide variety of classrooms. Royalties associated with software sales return to the Center to continue to support research and innovation.

For more details see: http://www.kaputcenter.umassd.edu/products/software/

There will be a new release of SimCalc MathWorlds® for Computer at the end of Summer 2011. The new release allows for the ability to import data using commercially known data probes, such as Pasco and Vernier probes, as well as text files.
Support PhD Program

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

Faculty in the Center developed a proposal for a PhD in Mathematics Education that is housed in the STEM department where they are tenured. This program was approved at the April 30th 2009 meeting of the MA Board of Higher Education. The program started in September 2009. The Kaput Center has worked closely with the STEM department offering research opportunities and authentic learning experiences for students through the work that is conducted on a daily basis.

The PhD in Mathematics Education program is split into three phases: (1) Introduction to Mathematics Education Research, (2) Preparation Phase for transfer to Advanced Doctoral Status, (3) Production Phase of Advanced Courses and Final Dissertation.

The program includes a mixture of core courses, authentic learning experiences in research institutions and projects, and an interactive thinking/writing process to develop cutting-edge research and discovery as part of their experience. Where possible, courses will be blended with a variety of delivery methods, including on-line video seminars, iTunesU/Podcasting, and active use of Blogs and Wikis as part of the regular mode of sharing and learning content, as well as expressing evolving ideas in and around coursework. A central Blog/Wiki will be available for students to interact and share their on-going work outside of classes. Systematic use of electronic learning support technologies will form the basis for cumulative evaluation of students’ learning and program success, as explained in the section of our proposal on program evaluation.
The program, with its supporting technological infrastructure, research associates and resources from the Kaput Center, will be a single coherent experience for students, bringing their learning in courses and interaction outside courses, to be an on-going and continual social experience for students at all times. Working together to develop their own skills and become innovative and creative thinkers, meeting critical educational issues and needs, in the 21st Century.

**Research Grant Proposal Activity**

*Funded Proposals*

**Title:** Democratizing Access to Core Mathematics Across Grades 9-12 (Award #: R305B070430)
*PI:* Stephen Hegedus (PI)
*Program/Agency:* US Department of Education, IES
*Amount Requested:* $2,215,548 (original funding $1,979,300 w/ supplement received 7/08 for additional $236,248)
*Dates:* July 1, 2007 – June 30, 2011

**Title:** Dynamic Haptic Geometry in Elementary and Undergraduate Classrooms (Award #: DRL-0835395)
*PI:* Stephen Hegedus (PI) & Nicholas Jackiw (Co-PI, KCP Technologies)
*Program/Agency:* National Science Foundation, REESE
*Amount Requested:* $570,258
*Project Dates:* July 1, 2009 – June 30, 2012

**Title:** Developing Algebra-Ready Students for Middle School: Exploring the Impact for Early Algebra (Award #: DRK-0918239)
*PI:* Maria Blanton (PI – UMass Dartmouth) & Eric Knuth (Co-PI, University of Wisconsin, Madison)
*Program/Agency:* National Science Foundation, DRK-12
*Amount Requested:* $1,583,670
*Project Dates:* September 1, 2009 – August 31, 2012

**Title:** Does it Work? (Award #: DRL-1036083)
*PI:* Chandra Orrill (PI – UMass Dartmouth), Andrew Izsak (Co-PI, University of Georgia), Allan Cohen (Co-PI, University of Georgia)
*Program/Agency:* National Science Foundation, REESE
*Amount Requested:* $999,958 ($186,417 brought to UMassD)
*Project Dates:* 2007 – 2010

**Title:** Diagnosing Teachers' Multiplicative Reasoning (Award #: DRL-0822064)
PI: Andrew Izsak (PI – San Diego State University), Joanne Lobato (Co-PI – San Diego State University), Chandra Orrill (Co-PI – UMass Dartmouth), Allan Cohen (Co-PI – University of Georgia), Jonathan Templin (Co-PI – University of Georgia) 
Program/Agency: National Science Foundation, DR-K12 
Amount Request: $944,163 ($21,090 brought to UMassD) 
Project Dates: 2008 – 2011

Title: Evaluation of the Implementation of the Smaller Learning Communities (SLC) Program at Dartmouth High School 
PI: Stephen Hegedus (PI – UMass Dartmouth), Brenda Berube (Co-PI, UMass Dartmouth) 
Program/Agency: Smaller Learning Communities, U.S. Department of Education 
Amount Request: $41,000 ($20,500 per year) 
Project Dates: October 1, 2009 – September 30, 2011

Title: CAREER: Coherence as a Basis for Understanding Teachers? Mathematical Knowledge for Teaching 
PI: Chandra Orrill (PI – UMass Dartmouth) 
Program/Agency: National Science Foundation, CAREER Program 
Amount Requested: $699,082 
Project Dates: April 15, 2011 – March 30, 2016

Proposals Pending or Unfunded
Title: K-20 Regional STEM Education Partnership for the South Coast & Cape Region of Massachusetts 
PI: Stephen Hegedus (PI – UMass Dartmouth), Maria Blanton, Jay Wang, Anthony Garro (co-PI – UMass Dartmouth), Jane Daly (co-PI – Seekonk Public Schools) 
Program/Agency: National Science Foundation, MSP Program 
Amount Requested: $9,902,301 
Date Submitted: October 2010 
Status: Under Review

Title: Children’s Understanding of Functions in Grades K-2 
PI: Maria Blanton (PI – UMass Dartmouth); Barbara Brizuela (co-PI – Tufts) 
Program/Agency: National Science Foundation, DRK-12 Program 
Amount Requested: $418,086 
Date Submitted: July 2010 
Proposed Dates: September 1, 2011 – August 31, 2013 
Status: Under Review


Establishing Industrial Collaborations

**Texas Instruments**

The Education Technology division of Texas Instruments continues to support the work of the SimCalc Research program presently funded by the US Department of Education. Melendy Lovett (President) and Dave Santucci have helped by loaning TI hardware to the Center for use in local MA districts. The division also promotes the work of the Center in their Research Briefs on-line and distributes versions of the SimCalc software. They also provided a generous donation to support the exposition and dinner on October 8th 2009.

**Apple, Inc.**

In January 2008, Stephen Hegedus and members of the SimCalc Research Team, and Jeffrey Wolfman (Vice-Chancellor for Advancement) were invited to Apple Headquarters in Cupertino, CA, to meet with John Couch, Vice-President for Education and Apple Senior Executives in Marketing. The team presented the work of the SimCalc Research Program. We are now working on establishing a relationship with Apple that supports and focuses on the following areas of development:
- Developing a network of researchers and practitioners on the Apple Learning Interchange
- Research and Development on new platforms including the iPod Touch/iPhone
- Distribution of SimCalc MathWorlds® on Apple’s Learning Carts
- Supporting Diffusion of Kaput Center initiatives through the Professional Development Network
- Establishing the Kaput Center as an Apple Center of Excellence

Establishing International Collaborations

The Director has continued to explore potential relationships with institutions in various countries. These have led to MOUs being established as Partnership Agreements between the University of Massachusetts Dartmouth and the following institutions:

- CINVESTAV, Mexico City, Mexico
- Tecnologico de Monterrey, Monterrey, Mexico
- UNIBAN, São Paulo, Brazil
- University of Cyprus, Cyprus
- Queensland University of Technology, Australia
The most recent MOU was signed with Queensland University of Technology, Australia. MOUs with Cinvestav, Mexico, Tec de Monterrey, Mexico, UNIBAN, Brazil and University of Cyprus, Cyprus were signed during the Showcase Event on October 8th 2009.

These MOUs secure various exchanges to enhance the collaborative educational and research missions of our institutions. They focus on student exchanges in our PhD program, faculty exchanges for the purpose of sabbatical or a focused study, and open exchange of ideas and prior work to develop R&D proposal.

View full MOUs at:
APPENDIX A

Journal Subscriptions
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<th>Publisher</th>
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<td>NCTM</td>
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<td>Educational Technology Magazine</td>
<td>Educational Technology Publications</td>
<td>$199.00</td>
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APPENDIX B

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 a 100-person 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
Luis Radford - Laurentian University
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
Ted Eisenberg - Ben Gurion University
Ana Sfard - University of Haifa
Dina Tirosh - Tel Aviv University

ITALY
Ferinando Arzarello - Università di Torino
Maria Allesandra Mariotti - Università di Siena

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

UNITED KINGDOM
Celia Hoyles - University of London
Barbara Jaworski - Loughborough University
Keith Jones - University of Southampton
John Mason - Open University
Elena Nardi - University of East Anglia
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 - Michigan State University
Corey Brady - Inquire Learning LLC
David Carraher - TERC
Allan Cohen - University of Georgia
Jere Confrey - North Carolina State University
Al Cuoco - Educational Development Center
APPENDIX C

Abstracts of Colloquium Series
Title: How is Creativity in Schools? Remarks on Intimacy, Identity & Motivation  
Speaker: Dr Stephen Hegedus, University of Massachusetts Dartmouth  
Abstract: In 1998, Sir Ken Robinson led a UK commission on creativity, education and the economy and his committee's report, All Our Futures: Creativity, Culture and Education was extremely influential at the time impacting schools and businesses. The London Times reported: "This report raises some of the most important issues facing business in the 21st century. It should have every CEO and human resources director thumping the table and demanding action." In my talk, I wish to position this report in 2010 and reflect on what progress has been made in the US. How is creativity doing in 2010 in US schools and do we need a Robinson report for the US today?

I shall draw upon data and my own empirical findings of 10 years of research in K-16 classrooms to present remarks that attempts to address this question through three theoretical perspectives. First, it is important to analyze how a student’s identity is critical, especially in how their work is respected and represented in social (e.g., classroom) contexts. Second, intimacy is a privacy dimension that needs to be better understood in order to decipher how people talk and share ideas in content-specific moments. Third and finally, motivation is a key problem for why we may not know how to teach students in the 21st century and this needs to be addressed in a knowledge paradigm vs. an inspirational-methodology context.

Title: The Forensic Science Crime Lab: CSI & URI  
Speaker: Dennis Hilliard, URI & The Rhode Island Crime Lab  
Abstract: The seminar will cover the various scientific principles and chemistries used in the examination of crime scene evidence. The examination of trace evidence, fingerprint and palm print evidence, firearms and tool mark evidence and DNA evidence will be discussed. The training and education of the crime scene investigator and the forensic laboratory scientist will also be covered during the lecture. A review of the Forensic Science Partnership at the University of Rhode Island will be discussed along with the presentation of several Rhode Island Cases, to illustrate the connections between physical evidence from the crime scene, the victim and the suspect.

Title: Perceiving and Conceiving in Mathematics and Science  
Speaker: Drs Robert Goldstone & Richard Lesh, Indiana University Bloomington  
Abstract: Scientific and mathematical reasoning depend on analytic thought, making novel and creative associations between dissimilar domains, and developing deep construals of phenomena that run counter to untutored perceptions. This has led many researchers to draw an opposition between
superficial perception and principled understanding. In this talk, I advocate the converse strategy of grounding scientific and mathematical reasoning in perception and action. I will describe empirical evidence for perceptual changes that accompany learning in science and mathematics. In science, my laboratory has explored the perceptually grounded transfer of scientific principles across superficially dissimilar pedagogical simulations. We argue that transfer occurs when students develop perceptual interpretations of an initial situation and simply continue to use the same interpretational tendency when interacting with a second situation. In arithmetic and algebraic reasoning, we find that proficiency in mathematics involves executing spatially explicit transformations to notational elements. People learn to attend mathematical operations in the order in which they should be executed, and the extent to which students employ their perceptual attention in this manner is positively correlated with their mathematical experience. For both science and mathematics, relatively sophisticated performance is achieved not by ignoring perceptual features in favor of deep conceptual features, but rather by adapting perceptual processing so as to conform with and support formally sanctioned responses. These "Rigged Up Perceptual Systems" (RUPS) offer a promising strategy for achieving educational reform.

Title: Data Games  
Speaker: William Finer, KCP Technologies & Dr Cliff Konold, University of Massachusetts Amherst  
Abstract: What if students have access to the data they generate when they play a game and can build a model of the game to use to improve their strategy? What mathematics and statistics can they learn in the process? And, by the way, what do they think about data and how it should be organized? The Data Games project (NSF DRK-12) is investigating these questions in middle school and secondary classrooms with new software built on top of Fathom and TinkerPlots.

Title: What Babies and Little Kids Tell Us About Algebra (Even for Big Kids)  
Speaker: Dr Paul Goldenberg, Educational Development Center (EDC)  
Abstract: Elements of number, arithmetic, symmetry, transformations, probability, and even algebra are built in, or develop in early childhood. Understanding this better could change the common belief that mathematical ability is grossly inequitably distributed. Except at the extremes, brain science tells us otherwise: mathematical capabilities that are often thought to belong only to "the top kids" are, in fact, built in to all normal babies. The huge gaps we see in school are largely artifacts of opportunity and expectation. Using examples from babyhood, elementary school, and high school, we’ll look at some of the "mathematical infrastructure" that supports algebra: the linguistics behind 24 - 4, the executive function behind 48 + 2, the two-dimensional written code of mathematics, the change of meaning of + between 3 + 5 and b + 5, and more.
**Title:** Stars in the Classroom: Teaching Geometry Through Islamic Art  
**Speaker:** Dr. Pamela Karimi, University of Massachusetts Dartmouth  
**Abstract:** As early as the eighth century the architectural landmarks of the Islamic world were adorned with geometric ornamental patterns, which Muslim artisans had inherited from antiquity. Over time, these decorations, which emerged due to the eschewal of figural imagery, became more sophisticated. The most distinguished design was an endless star-shaped motif that appeared on both flat and curvilinear surfaces. At first glance, these forms appear as outcomes of duplicating star-shaped units. But, interwoven Islamic star-shaped tessellations necessitated elementary forms of cut-tiles or wood-inlays. These compound pieces were by-products of an intricate geometry, involving circles and straight lines running in interlaced forms. Master builders of the Islamic world scribed these drawings on large paper scrolls, which were then traced on to architectural revetments. This underlying geometry can be studied through decorations in numerous existing medieval monuments, including the palaces of Madinat al-Zahra (10th c., Spain), Khirbat al-Milțar (8th c., Jordan), and the tower of Ghazni (11th c. Afghanistan), which implemented six, eight, and fourteen pointed-stars, respectively. While most of these star-shaped motifs used periodic tiles, some girih tiles (or strapworks of geometric stars and equilateral-polygons) were quasi-periodic. Examining the girih tiles of Darb-i Imam shrine (15th c., Iran), a recent study revealed a striking similarity between girih tiles and penrose tiles or geometric patterns with unusual symmetry. This complicated pattern was known among Muslims five centuries prior to its discovery in the West. Drawing on the work of scholars such as Branko Grćnbaum, G. C. Shephard, Jules Bourgoin, A.J. Lee, Peter J. Lu and Paul Steinhardt, who have provided solutions for deciphering the logic behind Islamic geometric designs, this paper offers multiple techniques through which art history teachers can enhance knowledge of geometry, while teaching the visual and architectural culture of Islam.

**Title:** What Do Career Education, STEM Education, and Policy Have in Common?  
**Speaker:** Dr. G. Michael Barnett, Boston College  
**Abstract:** With the recent release of the Above the Gathering Storm Revisited there is a renewed focus on improving STEM education within the United States. In this talk, we will examine the results of international evaluations and break down the numbers to better understand exactly where the major disparities are within the US education system and how educators in both formal and informal contexts are working to improve the STEM education. We will correlate these efforts with policy decisions and how the federal government is striving to encourage young people to enter STEM fields. Drawing upon our National Science Foundation-funded work for the previous seven years along with other NSF-funded programs, we will examine the successes and challenges that are faced when attempting to change STEM education within K-12 settings and what strategies appear to be successful in creating meaningful change.
Title: Design, Research, and Design-Based Research Methods: How Can We Improve and Study How People Live and Learn with Their Technology?
Speaker: Dr Chris Hoadley, New York University
Abstract: In this talk, I frame the fundamental problem of educational research as the design of useful educational systems. I discuss the similarities and differences between attempts to improve design through generalized research vs. to improve design through embedded forms of research. Design-based research methods blend these approaches and can be used in a wide variety of educational research settings, and I provide examples from several research projects in the dolcelab, including the design of collaboration tools for middle school science education, and the design of sustainability education for rural Himalayan villages. Finally, I give some practical recommendations on how to carry out design-based research methods in a methodologically sound way.

Title: Designers Speak: Challenges in US Mathematics Education Through a Curriculum Developers Lens
Speaker: Dr Glenda Lappan, Michigan State University
Abstract: The need to improve the teaching and learning of mathematics has been a focus of attention in the US over our entire careers. There have been waves of National interest in mathematics education that have attracted mathematicians and mathematics educators to the work of improving K-12 mathematics education. Today we will focus our remarks in two areas, our own curriculum development work including the story of how we came to engage in and accomplish the work and our comments on the challenges we face in future work to improve mathematics teaching and learning. We expect that many of the challenges we see are also challenges for mathematics education worldwide. First we will share relevant aspects of the work in which our research and development group have engaged for over 35 years. Many of these remarks are based on other papers that we have published about our work. But for this special audience we would like to tell you a bit of our personal stories.
APPENDIX D

5-Year Strategic Plan for the Kaput Center 2007-2011 (revised 12/2009)
Preamble

The Kaput Center is a 21st Century R&D operation, which focuses on expanding the learning frontiers of the education of our children in schools and higher education. It is primarily funded by external grants and focuses on long-term cutting edge research that transforms education in the areas of science, technology, engineering and mathematics (STEM). The majority of the members of the center are faculty or students in the newly established STEM department at UMass Dartmouth with other associates coming from higher-education institutions, research institutes and industry. The work of the center continues to inform scientists, policy makers and educational practitioners around the world of new discoveries into how children and adults think, learn, discover and understand mathematical and scientific ideas. In turn, the work of the center fuels new programs in teacher preparation and the fields of mathematics and science education research including the psychology of learning, curriculum that transforms what is normally taught in the early grades, and educational technology that impacts learning, motivation and communication through dynamic and embodied forms of representations.

Operationalizing the Plan

The original Kaput Center 5-year strategic plan was presented conceptually to Provost Garro in 2006 and was incorporated into a memo and submitted to Chancellor MacCormack in 2007. A revised memo was sent to the Chancellor with the FY07 end-of-year report and evolving by-laws in September 2008.

This memo serves as a historical synthesis and presentation of the 5-year plan for the Kaput Center (2007-2011). It also offers an assessment of whether the goals and objectives of the plan have been met to date and what critical needs are in effect from year to year. Unless a critical need is noted all items/goals in the agenda where met and documented in our end-of-year reports that can be found on-line at the Kaput Center’s website. Please note that the items/goals are cumulative from year-to-year unless it has been explicitly revised or removed.

This memo also offers a forward-looking revised proposal for years 4 (2010) and 5 (2011) given the recent restructuring of the Kaput Center to enhance its mission

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1 The Kaput Center was officially created by President Jack Wilson on February 14th 2007 but since the strategic planning began in Fall 2006 we use January 2007 as a start date for year 1.
in incorporating Science, Technology and Engineering education into its general purview of educational research and learning sciences. In addition, three divisions were approved to structure the work of the center, attract new researchers and faculty in an interdisciplinary fashion, establish new forms of R&D and extend the work of the center into policy and broader impact. These are: (1) Learning design, (2) Teacher quality, and (3) Education policy. These changes were approved by the Executive Board in August 2009 and by the Chancellor on September 24\textsuperscript{th} 2009

\textbf{Stephen Hegedus, PhD}\n
Director
Strategic Plan

2007

2007.1. Establish a preliminary set of by-laws and a document on how the Center will operate subject to its mission. This will include a description of the structure of the Center, the duties of all elected members including the Director, the Executive Board, research associates, and standing committees.

2007.2. Establish an executive board of no more than 15 members from local experts in education research, policy and institutional operations (K-12 and Higher Education).

2007.3. Establish an advisory board from outside the University of Massachusetts Dartmouth that will work with Kaput Center associates on projects and advocate for the work of the Center.

2007.4. Establish the standing committees for research and planning.

2007.5. Establish the K-16 Regional Math Ed network to reach out to the local community to create partnerships that will sustain research efforts and impact local schools directly.

2007.6. Establish the Colloquium Speaker series to invite 5-6 significant speakers to the Center throughout the academic year.

2007.7. Establish an on-line Famous Author Series to study the work of one important author in educational research.

2007.8. Establish a web site to promote the work of the Kaput Center.

2007.9. Seek external funds from federal agencies to support ongoing R&D initiatives.
2008

2008.1. Sustain all goals from 2007 seeking to increase capacity where necessary

2008.2. Widen the scope of the colloquium series to include a more diverse background of speakers

2008.3. Seek external funds from federal agencies to support the work of the Kaput Center at a national level (a.$500K per year).

2008.4. Establish an electronic and paper system to publicize & promote the work of the Kaput Center at a national and international scale.

2008.5. Document all progress of the Center work on-line. This will include all presentations, end-of-year reports and work.

2008.6. Establish on-line services to support the work of the Kaput Center worldwide, e.g., Wiki

2008.7. Establish the Foundational Issues Symposium through the Kaput Center advisory board to develop white-papers or position statements for US Congress.

2008.8. Complete the operations and by-laws agreement with full approval from Chancellor MacCormack.


2008.10. Explore commercialization of faculty innovations

2008.11. Establish a Kaput Center endowment through the UMass Foundation. Work with Advancement to investigate how private investors or foundations can support the work of the Kaput Center, e.g., Apple, Inc., Texas Instruments, Kauffman, Gates, MacArthur, Toyota, ExxonMobil and Siemens.


Critical Needs:

1. The Center deliberated on its identity and position within a new School of Education, Public Policy and Civic Engagement that was being developed and approved during the year. The new school was
established in September 2008. The Kaput Center was affiliated to it but continued to promote itself as an inter-college ("University Center") because of the multi-disciplinary aspects of its work and its mission to conduct innovative work. It became a pressing need to understand how it could work in collaboration with a new STEM department as well as fulfill its original mission. Because of this, the By-Laws and operations document of the Kaput Center has not been signed by the Chancellor.

2. An endowment for the Kaput Center has not been set up. We are still working with Advancement on what our fund-raising plan involves in terms of principal for R&D and return for student scholarships.

3. Whilst we hosted two Symposia, no white-paper was produced. Need to assess what this means in the long-term given the fragmented nature of the advisory board.
2009

2009.1. Address critical needs from previous year and sustain all goals from previous years seeking to increase capacity where necessary or establish capacity.

2009.2. Seek external funds from federal agencies to support the work of the Kaput Center at a national level (a.$500-1000K per year).

2009.3. Enhance on-line services to support the work of the Kaput Center worldwide as needs be and evaluate the future of Web 2.0 (or 3.0) applications.

2009.4. Build Kaput Center endowment through the UMass Foundation to $500K. Work with Advancement to investigate how private investors or foundations can support the work of the Kaput Center.

2009.5. Evaluate impact of Kaput Center products on educational policy.


2009.7. Enhance the mission of the Kaput Center to incorporate STEM disciplines.

2009.8. Establish three divisions to structure the work of the Center, attract new researchers and faculty in an interdisciplinary fashion, establish new forms of R&D and extend the work of the Center into policy and broader impact. These are: (1) Learning design, (2) Teacher quality, and (3) Education policy.

Critical Needs:

1. An endowment for the Kaput Center has not been set up. We are still working with Advancement on what our fund-raising plan involves in terms of principal for R&D and return for student scholarships.
2. Now that the MOUs with international institutions are established, what forms of exchanges can occur and how will they be supported? (e.g., US ED Atlantis or Erasmus programs).
3. Assess how the three focus areas will operate and what impact they will have. Do they need resources?
4. With the advancement of a web streaming service, the Kaput Center has invested in hardware to support its online seminars and video conferencing. We need to find a dedicated solution to support equipment, monitoring and management of web services given we have no budgeted IT support.
5. Because of the new STEM department, the Kaput Center is now cost-sharing in terms of space and facilities. It needs to ascertain how temporary this is and how it can be resolved fiscally.

6. There are no pre-doctoral programs this year supported by the NSF or US Education’s Institute of Education Sciences for Math Ed students. It is unclear (outside of private donations) how we can support research students at this time.
2010

2010.1. Address critical needs from previous year and sustain all goals from previous years seeking to increase capacity where necessary or establish capacity.

2010.2. Seek external funds from federal agencies to support the work of the Kaput Center at a national level (a.$1-1.5m per year) expanding to support the new cohort of PhD students in Mathematics Education.

2010.3. Build Kaput Center endowment through the UMass Foundation to $1m. Work with Advancement to investigate how private investors or foundations can support the work of the Kaput Center.

2010.4. Investigate impact of Kaput Center products on educational policy and work with lobbyists to promote the work of the center in DC. Seek earmarked funds, and alternative funds.

2010.5. Establish the operations and agenda of the three focus divisions of the Kaput Center with corresponding Heads.

2010.6. Host a third Foundational Issues Symposium on Creativity and Learning structured by the three new focus areas. Seek to attract a diverse audience to finalize a white paper for MA Governor’s Office and US Secretary of Education on “What is STEM Education?”

Critical Needs:

1. Assess how new plans (in red) affect the overall running and operational budget of the Kaput Center
2011

2011.1. Address critical needs from previous year and seek external funds from federal agencies to support the work of the Kaput Center at a national level (a.$2m per year) expanding to support the new cohort of PhD students in Mathematics Education and 1-2 post doctoral fellows. This is a steady state budget to support R&D and pre-/post-doctoral programs at the Kaput Center.

2011.2. Continue to work with Advancement to increase the Kaput Center endowment to $1m. First Kaput Center scholar to be awarded in Fall 2011. Future plans would increase the endowment to $2m with matching stage funds (50%) this would yield 6 doctoral student fellowships per year in perpetuity from 2012 onwards. First cohort of PhD students to graduate in Summer 2013.

Critical Needs:

1. Even with such a donation stream reassess how the endowment would grow as projected with present economic crisis.
APPENDIX: Critical Needs Assessment Presented to MA Officials
(12/2009)

The Kaput Center is a 21st Century R&D operation, which focuses on expanding the learning frontiers of the education of our children in schools and higher education. It is primarily funded by external grants and focuses on long-term cutting edge research that transforms education in the areas of science, technology, engineering and mathematics. Some of the members of the center are faculty or students in the newly established STEM department at UMass Dartmouth. The work of the center continues to fuel new programs for teacher preparation and the fields of mathematics and science education research including the psychology of learning, curriculum that transforms what is normally taught in the early grades, and educational technology that impacts learning, motivation and communication. The PhD program is supported by the Kaput Center by offering research students authentic learning experiences on new projects in MA and with partners around the world.

In order to meet the objectives of the preliminary 2007 5-year strategic agenda of the Kaput Center, critical needs exist in three areas: (1) Research and Program Development, (2) Supporting Collaboration, (3) Diffusion & Advocacy.

(1) Research and Program Development

a. In order to successfully complete federally-funded longitudinal implementations, we need student level data of all the MA children in our projects. Schools have not been forthcoming with such datasets even though our IRB approved consent and assent forms have allowed us the permission we need. We need a state mandated approach to supply data on students in our study in order for us to evaluate what factors predict success in our program. Our hierarchical linear models need the following data on individual students: (i) Ethnicity in DESE 2-digit format, (ii) SES (free/reduced lunch), and (iii) MCAS scores for grades 6, 7, 8, and 10. Student anonymity is upheld at all times.

b. Scale-up the use and implementation of Kaput Center research products that have been developed under rigorous efficacy methodologies (e.g., Randomized controlled trials) to some of the most needy school districts in MA. We are ready to deploy—at a district or regional level—our technology and curriculum programs that have demonstrated a significant impact on learning and motivation. We will continue to collaborate with the UMass Donahue Institute to ensure that fidelity of implementation is achieved, and to evaluate under what conditions inefficiency occurs.
c. *Broader impact:* State funds or matching funds to support the extension of the work of the Center into academic programs that impact the preparation of teachers and scientists. Travel grants for doctoral students.

(2) **Supporting Collaboration**

Our work relies on a diverse network of researchers, educators and industrial partners. In addition to our R&D efforts, the Kaput Center organizes a K-20 Regional Network (see http://www.kaputcenter.umassd.edu/projects/network/schools/) in Massachusetts focused on Science, Technology, Engineering and Mathematics Education to bring people together to establish a professional learning community. We are investigating how the strengths of the people in our network can help regional districts with various needs.

**Needs**

- This work is supported by UMass Dartmouth but seeks collaboration, promotion and further support from the Commonwealth of MA as the network grows
- Evaluation support to assess what educational strengths, weaknesses, opportunities and threats are of the south coast region as a whole
- Understanding the role of local businesses and the legislative delegate in implementing systemic reform initiatives in an effective way
- Identifying this as a regional initiative and the strength of regionalization both for economic as well as educational development
- Building support for public identification as the premier state institution in STEM education research in MA.

In turn, this collaborative can establish the infrastructure necessary to initiate a large-scale Mathematics & Science Partnership grant or a regional systemic reform initiative.

(3) **Advocacy & Diffusion**

Advocacy needs to take place at the state and nation level to meet our goals. The work of the Center is internationally known and our research products are being implemented around the world. Global expansion is happening now and advocates for our current efforts need to educate state leaders in order for us to continue this growth in the future. Grassroots efforts with regional legislative or local industry meetings can cultivate a movement of advocacy for our essential work to flourish and scale-up across the nation. Presentations synthesizing this work can be found here: http://www.kaputcenter.umassd.edu/events/presentations_and_workshops/
We have recently completed a diffusion study of one of our educational technology projects in Texas (http://www.kaputcenter.umassd.edu/products/technical_reports/). Such studies of how and why teachers continue to use educational technology in an effective way and how they share it with other teachers, offer critical findings that are of relevance on a large scale. This needs to be translated into policy. The Center’s findings are supported by research-based methods and rigorous assessment. Our approach using research and assessment to drive education reform is unique and as such needs to be emphasized and shared by others when advocating its due purpose in influencing education policy.