

# Education Letter

A publication of the Faculty of Education

Spring/Summer 2013

## The Many Faces ...

The Many Faces of Community Outreach .....1

Community Outreach and Public Education in Science, Technology, Engineering and Mathematics (STEM) Education .....4

The Queen's Faculty of Education Community Outreach Centre: History and Development .....8

Queen's Community Outreach Centre: An Evaluation of Three Signature Initiatives ..... 14

Learning Math and Loving it! ..... 25

The Power of Informal Science Learning ..... 29

Inspiring the Next Generation of Scientists, Innovators and Engineers ..... 33

Science as Art in Contemporary Theater ..... 37

On the Diversity of Research Partnerships and their Challenges in Social Science ..... 41

Interpreting Science for the Public, Fostering Critical Thinking and Separating Sense from Nonsense ..... 45

## The Many Faces of Community Outreach

A NOTE OF WELCOME FROM THE GUEST EDITOR, Lynda E.C. Colgan

I met Shirley Fairfield on Tuesday September 8, 1992. That was the date of my first day as Mathematics Coordinator for the Board of Education for the City of Scarborough, and the day that my professional life was changed forever.

Within moments of sitting at my new desk, Shirley suggested that I attend a *Family Math* program later that week. I agreed, not knowing what *Family Math* was, or how it could possibly relate to my role or career.

Two days later, when I entered the gymnasium at Alexmuir P.S., I knew immediately that I was in the midst of a significant transformative educational experience. The gym was magical: an explosion of colour, activity and sound. Balloon bouquets marked activity centres spread across the floor. At one, parents and children solved toothpick strategy puzzles; at another, they sought out numerical patterns on calendars. In one corner, families used string to determine members' body type: perfect square, tall or short rectangle. Diagonally opposite, giant tans took centre stage as letters, numbers and animals were pieced together using the rules of the ancient Chinese tangram puzzles. Along the way, families were challenged by puzzles and problems that involved everyday conundrums: *measuring without a ruler; determining the height of a tree; calculating change at a bake sale without a calculator; deciding how much water to take on a camping trip; doubling recipes; wrapping presents without wasting gift wrap; and, planning a garden.*

... continues on page 2

... continued from page 1

What I recall vividly, more than one quarter century later, was that laughter, engagement, and teamwork were consistent elements of the cross-generational learning that was taking place.

My professional philosophy was born then and there:

- 1 Mathematics content must be contextual, purposeful, and relevant. There should be *hands-on* and *heads-in* components in every opportunity to learn: physical manipulatives, models, and experiments are the building blocks of cognitive activities such as conjecturing, observing, extrapolating and explaining.
- 2 Curriculum was richest when integrated: music and movement illuminate fractions and transformational geometry and history comes alive when applied mathematicians like photographer Wilson “Snowflake” Bentley, Underground Railroad Conductor Harriet Tubman and author Jonathan Swift set the stage for learning.
- 3 Fun, laughter, enthusiasm and curiosity are co-requisites to learning.
- 4 Every child has many teachers, parents, peers, educational assistants, siblings and professional educators, each of whom makes unique and distinct contributions to learning, growth and development.
- 5 Classrooms can be within the walls of a school or be defined by playgrounds or natural expanses, having no physical boundaries.
- 6 Meaningful instruction can be planned or spontaneous when a knowledgeable, passionate and creative teacher is the facilitator.

Shirley’s invitation to a *Family Math* helped me to set my professional compass and plan my professional journey: one that has brought me to my role as Coordinator of the Queen’s Faculty of Education Community Outreach Centre (QCOC), where I have the privilege and pleasure to enact my philosophy daily while working to achieve the QCOC’s goal to improve the outcomes for children and youth who are “at-risk” in science, technology, engineering, mathematics (STEM) education and literacy.

The authors who contributed their perspectives, expertise, experience and enthusiasm to this special edition of *The Education Letter* focusing on Community Outreach have written excellent pieces that showcase and complement the many exciting STEM initiatives undertaken at the QCOC: public education events, informal learning environments, extracurricular engagement projects, community-university research collaborations, art-based mathematics programs, and family involvement series. They represent the academy and the community: a balance that reflects the fact that the QCOC values and respects the assets and diversity of each.

I would like to extend to them my sincere appreciation for their individual commitment to this group effort. And to the readers of this special *Community Outreach* edition, I extend this wish: may you find in these articles the concretization of Margaret Mead's famous quote

*"Never doubt that a small group of thoughtful,  
committed citizens can change the world; indeed,  
it's the only thing that ever has."*

*Lynnda Colgan*



We use a paper doll chain to represent the work of the Community Outreach Centre. The chain's diminishing perspective is to show inclusiveness of all ages. The figures' raised arms are meant to form an invitational arch, while their interconnected limbs show mutual support and respect. The alternating colours and genders are to symbolize diversity, inclusivity and the collective identity made possible through community-university collaborations.

# Community Outreach and Public Education in Science, Technology, Engineering and Mathematics (STEM) Education



GARY GOODYEAR, Minister of State for Science and Technology

*Gary Goodyear was first elected to the House of Commons in 2004 and was re-elected in 2006 and 2008. On October 30, 2008, he was appointed Minister of State for Science and Technology, and on August 13, 2009, he was named Minister of State responsible for the Federal Economic Development Agency for Southern Ontario (FedDev Ontario) by Prime Minister Stephen Harper. Prior to entering federal politics, he practiced chiropractic medicine and worked as an advisor to investment firms in the biomedical industry. Dr. Goodyear attended the University of Waterloo, specializing in kinesiology and psychology, before graduating from Canadian Memorial Chiropractic College. He worked his way through university as a meat packer and labourer.*

**L**ast fall, the Council of Canadian Academies reported on the state of Canadian science and technology (S&T). It concluded it was healthy, growing, internationally competitive and very well respected.

The council surveyed more than 5,000 international researchers, who ranked Canada's S&T as fourth in the world, behind that of the United States, the United Kingdom and Germany. With less than half a percent of the global population, Canada produces more than 4 percent of the world's scientific papers and nearly 5 percent of the world's most frequently cited papers.

According to the Organization for Economic Co-operation and Development, Canada continues to lead the G7 in higher-education expenditures on research and development, expressed as a percentage of GDP.

We are also attracting top talent from abroad. Over the past decade, there has been a net migration of researchers into the country. We can now have brain gain in Canada rather than the brain drain we experienced in late 1990s.

Clearly, Canada is punching well above its weight in scientific expertise. We can take pride in this tremendous accomplishment, as Canadians and as members of the global community. Scientific advancement knows no borders. It benefits everyone.

As Minister of State for Science and Technology, I want to ensure that we continue to strengthen our enviable position by promoting innovation, attracting high-quality researchers and encouraging a culture of investigation and discovery. Today's young

scientific explorers will be the next generation of Canadian innovators, entrepreneurs and problem solvers. We must nurture their passion and curiosity about the world. To do that, we have in place an array of programs to inspire them.

Consider, for example, the Natural Sciences and Engineering Research Council of Canada's PromoScience program. It helps children develop valuable critical thinking skills, meet role models and gain hands-on exposure to science: whether learning about ecosystems while on a hike with a scientist or mulling over futuristic machines at a robot camp.

In 2012, 49 organizations, including universities, non-governmental organizations, museums and science centres, received new funding under the program to help bring science alive for young Canadians.

In Southern Ontario, the Youth STEM Initiative—Youth in Science, Technology, Engineering and Mathematics—is helping young people recognize the rewards of an education or career in the sciences. Through Youth STEM, FedDev Ontario, the Harper government's economic development agency for Southern Ontario, provides investments that help not-for-profit organizations deliver science education programs in schools and at events throughout the region.

With our support, these organizations allow students to discover science through hands-on activities, workshops and interaction with scientists in their own classrooms. Youth STEM has funded such initiatives as Actua, Earth Rangers, FIRST Robotics Canada, Let's Talk Science, Partners in Research and Scientists in School.



... continues on page 6

... continued from page 5

The National Research Council of Canada (NRC) also introduces young people to science. Each year, the NRC works with Sanofi BioGENEius Challenge Canada, a national biotechnology-focused competition, to engage students in the science of biotechnology and its applications in health care, agriculture and the environment. High school students are paired with mentors who guide their research and help them conduct experiments in world-class facilities, including laboratories at the NRC.

All forms of knowledge are important to promoting innovation. In addition to student programs, it is critical that we promote information sharing and collaboration among diverse teams of researchers.

*In addition to student programs, it is critical that we promote information sharing and collaboration among diverse teams of researchers.*

The Social Sciences and Humanities Research Council of Canada (SSHRC) is supporting research that will help build a better understanding of important societal issues. As part of its Connection program, the council awards grants to researchers at post-secondary institutions across Canada. Connection Grants support workshops, colloquia, conferences, summer institutes and other events and activities that engage researchers and their communities.

SSHRC also oversees the Partnership Grant program. In its 2012 cohort, there were a number of projects that involved issues of great importance to Canadian communities. For example, the Canadian Centre for Policy Alternatives received a Partnership Grant to study community-based solutions for Aboriginal and inner-city poverty. Saint Mary's University received a similar grant to explore local-level environmental stewardship on land and sea. And at the University of Toronto, a SSHRC Partnership Grant supported research into trends, processes, consequences and policy options for Canada's large metropolitan areas.

Our government is committed to ensuring our brightest minds succeed at every step of the discovery process. The annual Prime Minister's Awards for Teaching Excellence and for Excellence in Early Childhood Education celebrate Canada's most innovative and outstanding teachers and early childhood educators.

Through scholarships, fellowships and research chair programs, we are promoting research excellence at every stage of academia.

While discovery-driven basic research remains a critical part of our government's approach, we also believe in the transformative potential of science in the marketplace. We are focused on a healthy innovation system—supportive marketplace frameworks, engaged citizens, highly skilled people and sound infrastructure. At a time when innovation is increasingly dependent on collaboration, Canada is taking a leadership role by providing programs that bring the private and public sectors together, creating a supportive climate for start-ups and attracting and retaining world-class expertise.

Our support for discovery-driven research through all levels of academia as well as for market-driven applied research is building the basis of a prosperous 21st century knowledge economy. Since 2006, we have invested nearly \$9 billion in new funding for S&T and innovation.



Canada will be the world leader if we continue to encourage risk taking, competitive spirit, creativity and bold new approaches to traditional challenges. By supporting programs that promote science and technology, we are preparing our children for the jobs of the future, creating a stronger economy and improving the quality of life of Canadians for years to come.



# The Queen's Faculty of Education Community Outreach Centre: History and Development



LYNDA E.C. COLGAN, *Community Outreach Centre, Queen's University*

*Lynda Colgan's career as a mathematics educator began in a secondary school more than 30 years ago. Since then her roles have been many: elementary and middle school classroom teacher; computers in education consultant (K-8); mathematics curriculum coordinator (K-12); researcher; teacher educator; administrator; university professor; newspaper and journal columnist; textbook author; children's book author and co-creator of a children's mathematics educational television program: The Prime Radicals. As Coordinator for the Community Outreach Centre at Queen's University (QCOC), Lynda participates in community-university partnerships and collaborations with organizations and agencies that work with children who are at risk in mathematics, science & technology (MST) and literacy.*

**E**stablished in 2009 with a leadership gift from Imperial Oil, the Queen's Faculty of Education Community Outreach Centre (QCOC) is an important hub for innovative programs and projects related to literacy, and science, technology, engineering and mathematics (S.T.E.M.) education. Currently, all QCOC programs are collaborations based in or with schools, museums, community organizations, Arts academies, and post-secondary institutions (Queen's, The Royal Military College of Canada and St. Lawrence College) with support from educators, S.T.E.M. professionals and expert volunteers from the greater Kingston community.

To define the mandate for the QCOC and set a meaningful agenda for its activities, it was necessary, first, to conduct a small study of "outreach" at the institution and in the community. The goal of the study was to gather data to complete a gap analysis in order to identify a unique niche for the QCOC and articulate a direction for its undertakings that did not overlap, duplicate, impede or negate the work of others whose mission also was "outreach." Data was gathered through conversations with faculty, local educators, school district administrators, post-secondary undergraduate and graduate students, parent council representatives and community members; departmental literature and on-line descriptions of "outreach" projects.

Data collection showed that there were more than 100 "outreach" projects at Queen's and hundreds more within the community. At the institutional level, there were many "outreach" programs organized by students. Some were individual initiatives, others were coordinated by student societies, and others by national organizations (e.g., *Let's Talk Science*). Others were supervised by faculty members, departments or schools, and supported by staff, faculty and students.



At the community level, the same variation existed. Some “outreach” programs were the product of one or two individuals while others were supported financially and in-kind by international (e.g., Girl Guides), national (The SNAP Mathematics Foundation), provincial (FED DEV Ontario) and local (Quinte St. Lawrence Mathematics Association, QSLMA) organizations.

At the institutional and community level, several important patterns emerged. First, most “outreach” programs were short-duration, special program foci implementations (e.g., *Go Eng Girl!* Day, the Queen’s Centre for Neuroscience *Brain Bee* Competition). Second, many “outreach” programs were summer day camps or school break enrichment camps—the former directed at elementary school students’ specific interests (e.g., environmental studies, athletics or art) and the latter aimed at supporting and recruiting “the brightest and the best” secondary school students for future enrolment at Queen’s. Lastly, in only a very few cases, “outreach” was actualized through sustained mentorship programs (high school robotics leagues [Faculty of Applied Science and Engineering] and after-school S.T.E.M. clubs [Professor Emeritus Henk Wevers at The Boys and Girls Club] or on-going buddy partnerships (Queen’s Alma Mater Society *Kaleidoscope*). In general, there were many more literacy, social skills, arts and athletics “outreach” programs than S.T.E.M. initiatives.

While the institutions or community organizations conducted little or no formal evaluation of the efficacy of the various “outreach” programs beyond exit surveys or participant satisfaction questionnaires for internal use only, the end-users described inconsistent quality with respect to curriculum alignment, instruction, age-appropriateness of content, program delivery, contact information, and collaboration. While end-users appreciated the good will and intent of “outreach” personnel, they were frustrated by difficulties in communication; rotational leadership; unreliable logistics; inconsistent coordination; inexperienced volunteers; and, lack of attention to details around issues of safety, equity and special needs.

The data underscored the fact that there is no commonly held definition of “outreach.” For some groups, “outreach” was the act of providing services to populations who might not otherwise have access to those services (e.g., tutoring). For others, it meant becoming involved in a community or effort (e.g., the annual *Fix*



**The Blackboard** by Winslow Homer.

I chose this painting because the marks on the blackboard puzzled scholars for many years. They now have been identified as belonging to a method of drawing instruction popular in American schools in the 1870s. In their earliest lessons, young children were taught to draw by forming simple combinations of lines, as seen on the blackboard.

... continues on page 10

... continued from page 9

and Clean event). Some “outreach” volunteers believed that they were filling a gap in the services provided by mainstream systems, organizations or agencies (e.g., *The Breakfast Club*). Regardless of their definition, all “outreach” groups and individuals believed that they were contributing to the personal growth, development, and education of the participants in their projects.

These findings were consistent with the literature related to “outreach” which states that the phrases “outreach” and “community engagement” have a multiplicity of meanings and can vary greatly depending on the institution, discipline and individual (Watermeyer, 2011). Similarly, the examples of “outreach” or “community engagement” that were identified are consistent with images of traditional, hierarchical models in which experts disseminate knowledge to the public (e.g., public seminars, university open houses, and performances and workshops in schools) (Watermeyer, 2011).



Bathsheba Grossman is an artist who explores the region between art and mathematics. Her work is about life in three dimensions: working with symmetry and balance, getting from the origin to infinity, and always finding beauty in geometry. This piece, *The 120-Cell*, is the 4D analog of the dodecahedron. Like so many of her sculptures this mathematical model has structure and order, yet its 120 cells and symmetries are hard to grasp. As you attempt to trace the labyrinthine formations, you are drawn in, mesmerized.

The literature also confirmed what we noted as a reluctance to participate in “outreach” on the part of some faculty and graduate students: the perceived norm by academics is that participation in public outreach is not recognized and rewarded by universities, which in turn, suggests that there will be negative repercussions for academic career advancement which requires “legitimate” research and teaching (Andrews et al. 2005; Moskal & Skokan 2011; Nicotera et al. 2011). University faculty have many roles to play and many professors believe that any outreach obligations detract from their teaching, research and publishing responsibilities.

Given the broad spectrum of “outreach” projects, definitions and intended outcomes, and community and faculty perceptions, it was clear from the outset that the QCOC faced an enormous challenge as it was formally launched into the institutional and community “outreach” collective in the greater Kingston Community.

We used data from our own needs assessment and from the literature to guide our direction and activities, based on principles of collaboration, capacity-building and research, and our own broad interpretation of students “at risk.” We believed that students could be at risk because of the challenges of low SES, but they could also be at risk because there were no accessible opportunities for curriculum enrichment; students could be at risk because parents (or other caregivers) were unable to support learning at home because of changes to the curriculum or because achievement was impeded by adult role models’ negative attitudes or dispositions; students could be at risk because their teachers were anxious about specific subject content and instruction; or students could be at risk because of deleterious societal perceptions. All of these are believed to be factors in S.T.E.M. education, and led to the QCOC’s predominantly S.T.E.M. program focus on informal education, mentoring, parent and public education and research partnerships<sup>1</sup> as well as our process standards.

This, in turn, made it possible to model the QCOC as having two complementary pillars that frame, support and inform the initiatives that serve the community and beyond in unique and influential ways: *Research-Based Innovations and Collaboration/Participation Networks and Partnerships*. There are four components to the first: Pre-Service Teacher Education, Community Research, Informal Education Opportunities and Program Evaluation. The second is also comprised of four components: Public Education, Student Engagement, Professional Growth and Knowledge Mobilization.

As the model illustrates, the “pillars” upon which we base all initiatives are non-hierarchical, dynamic and connected, and have a common goal of advancing literacy and S.T.E.M. education. The work of QCOC strives to bridge the gap between research and practice through its participatory action research projects and professional learning opportunities. The organic flow of the two pillars of the model represents the fundamental tenets upon which all QCOC “outreach” projects are based: collaborative partnerships

*We used data from our own needs assessment and from the literature to guide our direction and activities, based on principles of collaboration, capacity-building and research, and our own broad interpretation of students “at risk.”*

<sup>1</sup> A full description of the activities of the QCOC can be found at <http://educ.queensu.ca/community/outreachcentre.html>

... continues on page 12

... continued from page 11

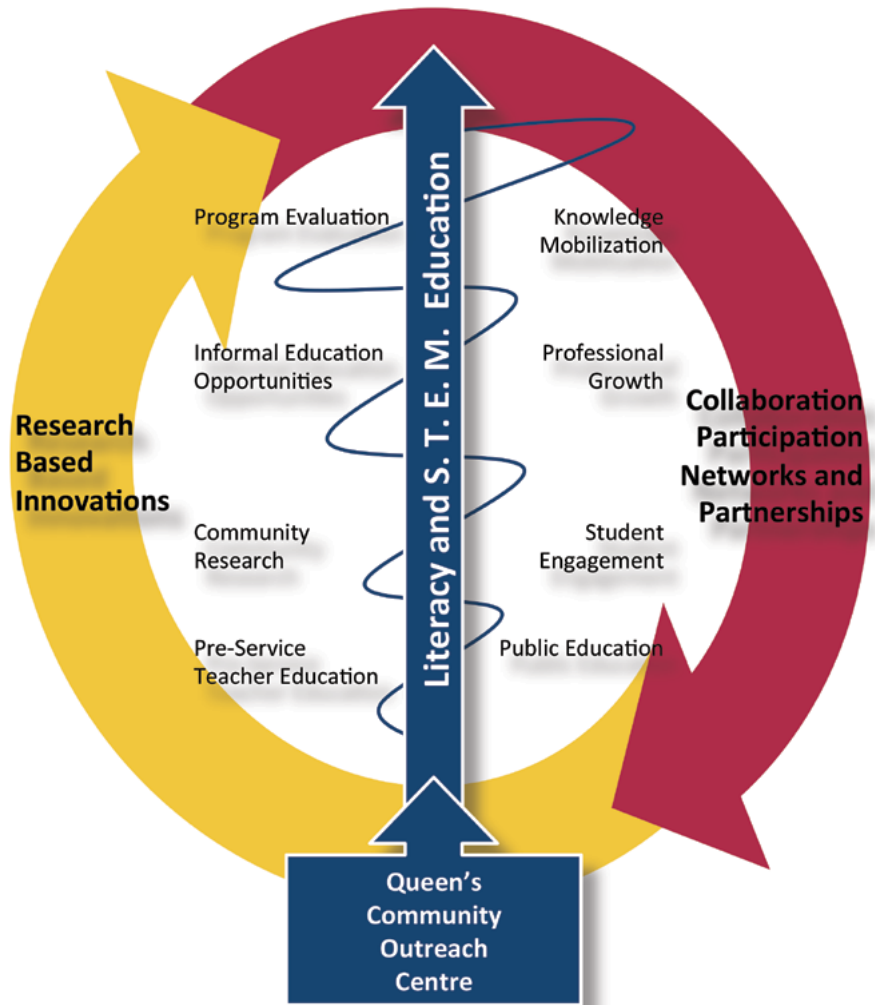


Figure 1. The QCOC Framework (adapted from the *Innovation and Education Cluster (HIEC)* model by Dawn Lawson.)

that are mutually beneficial, established through reciprocal trust and respect, constructed through shared decision-making, and active engagement of all affiliates.

Since 2009, our projects have ranged from *Mathematics Courses for Parents* to the premiere of *Mathakazam!* a puppet play for young children that stresses the importance of mathematics in the real world. The QCOC has hosted professional learning programs for teachers in collaboration with national organizations such as *Youth Science Canada* and *Let's Talk Science* and provided opportunities for students in at risk communities to engage with scientists through robotics. We have placed early career teachers with non-traditional mentors in research laboratories, music studios and museums, and provided



the resources for community organizations to conduct small empirical studies to improve and build upon existing programs for children and families. We have celebrated S.T.E.M. with *Chemistry Magic Shows*, turtles, steam and ice cream made with liquid nitrogen and supported families as they conduct S.T.E.M. experiments and lessons at the kitchen-table and in the backyard using freely accessible resources. The QCOC has built bridges among institutions and has applauded students as they have tested the strength of their own unique bridges.

The QCOC has invested in the community, and in return, the community has invested in the QCOC. As the QCOC moves forward, we will continue our program of collaboration, research and review so that we can make a lasting contribution in the spirit of these words from Dr. Gary Goodyear, Minister of State for Science and Technology,

When a child's interest in science is sparked, it can ignite a passion for exploration and discovery that lasts a lifetime. A fascination with a caterpillar's transformation can develop into a lifelong love of the biological sciences. A child's determination to construct a tower of unparalleled height can transform from a playground project to a feat in engineering. In a child's eyes, there are no limits.

— Media Planet, STEM Education, November 2012.



#### REFERENCES

- Andrews, E., Weaver, A., & Daniel, H. (2005). Scientists and public outreach: Participation, Motivation, and impediments. *Journal of Geoscience Education*, 53(3), 281-293.
- Moskal, B., & Skokan, C. (2011). Supporting the K-12 classroom through university outreach. *Journal of Higher Education Outreach and Engagement*, 15(1), 53-75.
- Nicotera, N., Cutforth, N., Fretz, E., & Summers Thompson, S. (2011). Dedication to community engagement: A higher education conundrum? *Journal of Community Engagement and Scholarship*, 4(1), 37-49.
- Watermeyer, R. (2011). Challenges for university engagement in the UK: Towards a public academe? *Higher Education Quarterly*, 65(4), 386-410.



# Queen's Community Outreach Centre: An Evaluation of Three Signature Initiatives



NANCY J. DALGARNO and LYND A E.C. COLGAN, *Community Outreach Centre, Queen's University*

*Nancy Dalgarno is the Educational Researcher for the Queen's Community Outreach Centre (QCOC) in the Faculty of Education at Queen's University. She collaborates with MEd and PhD students to design and research community outreach projects focused on Science, Technology, Engineering and Mathematics (STEM) education in partnership with local community organizations, and conducts program evaluations of all QCOC initiatives. Previously, Nancy spent 15 years as a Mathematics, Science and Technology teacher in public, private and international schools. Nancy has written Science and Technology textbook chapters and handbooks, published articles in peer reviewed journals and presented at educational conferences that focused on STEM education. She recently won the International Award for Excellence in Learning and Education for a paper published in the Journal of Ubiquitous Learning.*

**M**ore and more of our youth today are involved in a wide array of extracurricular activities that enable them to develop knowledge, skills and social connections they may not otherwise acquire (Gee, 2001; Lee & Hawkins, 2008). Schools are only one of a number of learning environments based in a community that help students learn (Irby, Pittman & Tolman, 2003). For instance, a recent study by the National Research Council concludes that "A great deal of science learning, often unacknowledged, takes place outside school in informal environments—including everyday activity, designed spaces, and programs—as individuals navigate across a range of social settings." (Bell et al. 2009, NRC report). Darling-Hammond (2006) indicates that if today's learning environments were based on collaborative structures inclusive of communities, universities, and schools, we would more effectively meet the challenges of educating children in the 21st century. The goal of the Queen's Community Outreach Centre (QCOC) is to collaborate with the community to expand opportunities, strategies and resources available to help educators, families and volunteers improve children's learning in literacy, and science, technology, engineering and mathematics (S.T.E.M.).

In 2013, the Queen's Community Outreach Centre's (QCOC) completed three, two-year studies that examined their flagship initiatives: (1) Alternative Practica Community Placements, (2) Community Research Partnerships, and (3) S.T.E.M. Outreach. The overall purpose of the studies was to evaluate the strengths, benefits, and challenges associated with collaborative community-university partnerships.

## Overall Method

An improvement-oriented evaluation model framed all three studies (Springer, 2010). Purposive and convenience sampling were used to achieve variation in the data (Creswell, 2002). All interviews and focus groups took approximately 60 minutes and were transcribed verbatim. Pseudonyms were used to help ensure confidentiality. Online surveys were distributed using SurveyMonkey and took participants approximately 10 minutes to complete. Analysis of qualitative data followed conventional approaches—thematic analysis and the constant comparative method (McMillan & Schumacher, 2006; Springer 2010). All qualitative data were coded using NVivo® analysis software to assist in determining emergent topics, categories and themes. The quantitative data from the surveys were analyzed using descriptive statistics that included percentages, means and frequencies. What follows is a description of each of the three signature initiatives and the findings that resulted from each of the studies.

## Background and Findings

The three research studies focused on pre-service teacher education, community-university research-based innovations, and collaborative outreach partnerships.

### Pre-Service Teacher Education: The Alternative Practica Community Placements Study

#### *Background*

Teaching is key to student success. Students need teachers who inspire and engage them and foster a climate of wonder, curiosity and inquiry. To advance literacy and S.T.E.M. education, a central focus of QCOC is to contribute to pre-service teacher education by providing expanded opportunities through which early career teachers may develop their S.T.E.M. education knowledge.

A unique feature of the BEd program at the Faculty of Education, Queen's University is the *Alternative Practicum*. The *Alternative Practicum* is a three-week opportunity through which BEd teacher candidates can learn about the abundance of opportunities for learning beyond the schoolhouse door. It provides practice teaching placements in informal learning institutions, community organizations, museums, and recreational settings. The goal of the *Alternative Practicum* is to illuminate the potential of non-school settings and unconventional, informal pedagogical strategies for teaching and learning. Through experiential teaching and learning opportunities in environments rich in real-world literacy and S.T.E.M. phenomena, the *Alternative Practicum* provides both novice educators and children first-hand occasions to pursue and develop literacy and science interests and engage with scientists.

*Alternative Practicum Community Placements* organized through the QCOC enable BEd teacher candidates to work in non-traditional educational environments and discover

*Students need teachers who inspire and engage them and foster a climate of wonder, curiosity and inquiry.*

... continues on page 16

*... continued from page 15*

the potential for innovative learning opportunities to advance student understanding in literacy and S.T.E.M. subjects. Between 2010 and 2013, 115 BEd Teacher Candidates participated in Alternative Practicum placements at the Centre, in local museums, community centres, schools and research laboratories.

Through the deliverables from the Alternative Practicum (demonstration lessons, museum education packages, teacher resource materials, working robots, public education events) the QCOC was able to achieve its mission to include learners of all ages, cultural and socioeconomic backgrounds and abilities in opportunities that bring literacy and S.T.E.M. to life in engaging and accessible ways.

The QCOC uses The Arts as a vehicle to reach S.T.E.M.- anxious students and challenge deeply embedded, negative societal attitudes towards S.T.E.M. We achieve this through the integration of music, dance and drama into S.T.E.M. subjects. It is known that by Grade 4, children say that while they enjoy science and design technology at school and appreciate the benefits of science and engineering to society, they do not wish to become scientists or engineers (Silver and Rushton, 2008). Other studies show that young students' enjoyment of S.T.E.M. declines each year thereafter until the end of mandatory science and mathematics education (Murphy, Ambusaidi and Beggs, 2006). Since research also shows that a negative disposition towards a subject and a lack of belief in one's ability to succeed is correlated to low achievement in that subject, it is important for young children to have a positive attitude towards these subjects (Reynolds and Walberg, 1992). It is also essential



for adults who have a direct impact on a child's development to stop perpetuating the myths that S.T.E.M. is difficult, unnecessary, irrelevant and limited to elite students.

### **Findings**

The two-year study of the Alternative Practica adopted a mixed-method design. Data were collected through interviews (I) with eight BEd students and seven community leaders who acted as supervisors, an online survey administered to teachers who took their classes to the puppet show, *Mathakazam*<sup>2</sup> (response rate = 55%), and an online survey distributed to teachers whose classes participate in the *Let's Talk Science* (LTS) program (response rate = 47%).

The qualitative findings indicate that most of the community leaders and BEd students found that the Alternative Practica experience provided unique opportunities to learn about non-traditional teaching opportunities. For example, one BEd student stated,

It opens your eyes to Alternative work environments. [It] gives you an idea of a different way things are done so you can incorporate that into a classroom. Or maybe even work there after graduation, that's always a possibility—working in colleges, working in museums, working in curriculum design. It's [the Alternative Practica] a good chance to explore that. It's also a good chance to apply your knowledge in a very different setting. I think [that is] very useful. (Alex, I)

One of the community leaders agreed when she stated that the BEd students,

Have more options than just being a teacher in a classroom. There are lots of other organizations out there that can make use of their skills.... The teacher candidates get the experience that teaching can occur in lots of different forms. Teaching doesn't just occur in the classroom, it can occur with all kinds of different community groups. I think this is a definite plus to the program, in that they do get that experience." (Mandy, I)

The analysis also suggested that the Alternative Practica experience assisted in changing participants' beliefs and practices about teaching S.T.E.M. education. The community leader for the puppet show stated that the BEd students were shown alternative ways to deliver the S.T.E.M. curriculum and they were telling her, "I like math now. I just want to go and do math" (Abby, I). She stated that the students "had a mental block against it [math], but they were all pumped. That was really neat to see." One of the BEd students

*It is also essential stop perpetuating the myths that S.T.E.M. is difficult, unnecessary, irrelevant and limited to elite students.*

2 To watch a production of *Mathakazam* and download the ancillary resource package developed to support teachers whose classes attended the performance, please visit <http://educ.queensu.ca/community/outreachcentre/resources.html>

... continues on page 18

... continued from page 17

who designed and implemented the LTS workshops for classes stated that he now knows how valuable it is to show students that what they “learn in class can be applied outside of the class.... So it’s useful for them to see what’s out there” (Jordan, I). Another student learned the value of letting youth “experience science” and “going into the classrooms and exciting the kids [about science]” (Jeremy, I).

Ninety-five percent of the teachers who viewed the *Mathakazam* puppet show believed it conveyed an important message about mathematics perceptions and addressed important content. Ninety-two percent stated that they would attend the show with their students again next year. Of the teachers who participated in the science & technology workshops, 100% said they would welcome BEd students into their classes again and they would recommend the suite of S.T.E.M. demonstration lessons to their colleagues to support the mandatory Science and Technology curriculum.

The study highlighted the authentic professional learning the Alternative Practica community placements provided for the BEd candidates in terms of increasing awareness of alternative forms of S.T.E.M. education and the importance of collaborating in non-traditional ways to deliver S.T.E.M. curriculum.

## Research-Based Innovations: Community Research Partnerships Study

### Background

Each year, the QCOC supports a number of local community organizations and agencies whose mandate complements or supplements its own goals and principles.

The purpose of the funding is to provide non-profit community organizations with the

resources (a Research Assistant and budget for consumable materials) to conduct a study that evaluates the impact of one of their community initiatives.

The Community Research Partnership projects, which are adjudicated annually in August, run from September to April. They culminate in a Poster Conference in May which celebrates





the studies by sharing the results with local educators, researchers, organizations and community leaders. The community-university relationship has historically been a hierarchical relationship that leads to community groups and university faculty working in parallel toward similar goals, which suggests there is little to no reciprocity of enactment in public education (Warren, 2011). The belief within the QCOC is that academic and community partnerships must be viewed and valued as multi-dimensional, authentic collaborative approaches and those universities should be involved in local initiatives by seeking out and supporting research essential to representative stakeholders, and making the results accessible and scalable. Very few universities or community-based organizations have collaboratively utilized community partners and graduate students to assist in researching evidence-based community projects that benefit the public in our area (Nicotera, Cutforth, Fretz & Thompson, 2011; O'Meara & Rice, 2005). QCOC is rare in its efforts to conduct evidence-based examinations of our community programs involving community partners, consumer representatives, university faculty, and graduate students: all of whom participate in the research design, implementation, and knowledge mobilization process. Eighteen local organizations, 18 Research Assistants (RAs) and 10 BEd teacher candidates have benefitted from our Community Partnership initiatives to date.

*Very few universities or community-based organizations have collaboratively utilized community partners and graduate students to assist in researching evidence-based community projects ...*

### **Findings**

The two-year study, which was completed in 2013, involved 12 programs that included 12 community leaders and 12 RAs from 2010–2012. Data were collected through semi-structured interviews with 12 community leaders and two RAs, one focus group of RAs ( $n = 5$ ) and a document analysis of the final posters produced from the 12 community programs funded.

The findings indicated that an overwhelming majority of both community leaders and RAs believed the strengths of these research partnerships was due to mutually collaborative team efforts. For example, one RA stated that,

I've learned that community partnerships...can be very successful. I think that we established a good working relationship. I learned a lot about teachers working together...I learned about the benefits of doing this kind of collaboration...this reinforced that these collaborations can work. (Troy, I)

One of the community leaders supported the notion that the shared-experience strengthened the community-university partnership when she stated, "She [the RA] had some good ideas and she was a part of our team" (Donna, I).

Providing an opportunity to study literacy and S.T.E.M. issues of significance to the community was also a theme that emerged from this study. Laura, an RA with one of the projects, stated that there were,

*... continues on page 20*

... continued from page 19

A lot of great programs out there but there is no research behind them. It opened my eyes to future jobs for myself [because] there is a need for research and the community is interested in research—it's not just the university. There are practical applications. (Focus Group)

Another RA stated that, as a result of this unique partnership, it was the first time that she immediately saw the benefit from the research: "I had a recommendation that came out of the data and I heard last night that they [have] actually already incorporated it" (Emily, Focus Group). One of the community leaders stated that the research helped to strengthen their programs' goals and objectives (Tammy, Interview). The document analysis of all twelve posters revealed that all participants, whether a child, youth, adult or parent/guardian learned from participating in the community program. For example, the ESSO Family Math participants learned about the Ontario mathematics curriculum, resources available, and how their own perceptions about mathematics influence their child's views (Penn, Ramsay, Dalgarno, Colgan, 2012).

Most participants stated that they applied the findings from these small-scale studies to support on-going knowledge mobilization efforts for their program and organization. They also said that the data analysis, poster and culminating reports facilitated the dissemination of the findings to a wider audience (e.g., conference presentations,



newsletters, professional publications and funding applications). Darcy, one of the RAs, stated that he had little experience, “with qualitative research. It was great; I got to conduct an interview properly [and] I wrote my first qualitative paper” (I).

It is important to note that, in some cases, involvement in the QCOC research studies provided career opportunities for students. One former RA is now the Coordinator of S.T.E.M. Outreach at an Ontario university, two BEd graduates have implemented *Family Math* programs in their schools, one BEd student became a program Coordinator with LTS and two RAs have used the Community Research project for their graduate thesis research.

It is unique community-university partnerships such as this that allow community organizations and universities to learn with, from and about each other to improve public education outreach opportunities. When community-university partnerships are redefined and based on collaboration and reciprocity, everyone involved both benefits and prospers.

### **Collaborative Outreach Partnerships: The Science Rendezvous Public Education Study**

#### ***Background***

*Science Rendezvous*, one of the largest science festivals in Canada, is a grassroots, non-profit national organization that partners with Canada’s top research institutions to present an annual science festival that is free for everyone. The event takes place annually on university campuses, research institutions and community sites across Canada on the second Saturday in May. As an event dedicated to showcasing the world-class scientific research happening right here in Canada, the goal of Science Rendezvous is public education. Science Rendezvous initiates direct involvement with Canadian science by presenting hands-on activities, exciting demonstrations and explosive experiments, lighting the spark of curiosity necessary to engage with and support Canadian science, technology, engineering and mathematics.

The goal of the program is to promote public understanding of the importance of science to our standard of living and global competitiveness, engage people in science, and to inspire the next generation of researchers and innovators.



... continues on page 22

... continued from page 21

QCOC has coordinated *Science Rendezvous Kingston* for three years. More than 250 volunteers from 35 Departments, Research Centres, and Laboratories from Queen's, The Royal Military College of Canada and St. Lawrence College, and 15 community organizations dedicated to scientific and environmental issues have volunteered their time, expertise and resources so that families and members of the public can meet and talk to scientists, engage in scientific experiments, and learn about possibilities of S.T.E.M.

### **Findings**

The purpose of the two-year study conducted by the QCOC was to evaluate *Science Rendezvous* to ensure *Science Rendezvous Kingston* met its goals for future iterations. Data were collected through semi-structured for 30 interviews and seven focus groups ( $n = 13$ ) with local scientists (including Graduate Students) and community leaders involved in *Science Rendezvous Kingston*. An online survey was also administered to anyone from the public (18 years and older) who came to *Science Rendezvous Kingston* and agreed to participate in the study (response rate = 35%).

Findings from the survey show that 85% of participants stated that science and technology was a subject of concern in their household. Most of the participants found the hands-on activities were age appropriate, engaging and inspired their children to be interested in and positive about science. For example, the following quotes from the survey data support this finding:

"[There were] interesting demonstrations that attract and retain the kids attention. The oscillating chemical reaction was great!"

"[There were] many hands on science activities. Great to see children getting involved and becoming excited about Science."

"[It was] interactive and accessible for young children. The scientists were entertaining and fun as well as knowledgeable."

"My daughter loved the goop/slime, the science magic, dressing up in the hazmat suit to collect soil/water samples, and making paper."

"Honestly, I and my daughter learned a ton about fundamental aspects of how the world works. Unfortunately, my science teachers were pretty bad as a kid. I wish there were more opportunities like this when I was growing up."

Survey participants also believed the take-home resources would help them bring science into their home environment. For example, as a result of *Science Rendezvous*, one parent

*Findings from the survey show that 85% of participants stated that science and technology was a subject of concern in their household.*

has taken her children on follow-up visits to the local geology museum. Another parent has performed science experiments, found in the take-home activity book, with her two children.

The preliminary data from the interviews and focus groups also support this finding. For example, one of the scientists stated that, "I had fun. I interacted properly with the people and the people showed an interest in what I was offering" (Harvey, Interview). Another scientist observed that, "It seemed very well attended.... The kids were interested in the material and wanted to hear about it" (Ruby, I).

The scientists also found that they learned effective teaching strategies for disseminating their research in a way that was easily understood to a diverse demographic. As Ruby, one of the scientists stated, "I learned that it's very hard to explain something quite technical to children but that it can be done and it can be fun. I guess just having that experience is really the benefit for me" (Interview). Another scientist believes she,

Learned a lot from being put in contact with so many different types of people from the general public, ranging from parents, parents who were university professors in other departments, down to two year old child. Explaining my research to that range of people is a strength in terms of what I learned from it [*Science Rendezvous*]. (Arwen, I)

One of the major themes that emerged from the interview and focus group data was the networking opportunities that *Science Rendezvous* offered for the scientists involved. Arwen supported this finding when she stated,

I do believe in the initiative, I do think it's a really important message that's being delivered. It's a great way to network and discover other people and other projects that they're doing within this community that [we] might be able to partner with.... We've already created a partnership out of that and that was a strength. (I)

The preliminary qualitative data also suggested that *Science Rendezvous* helps build stronger communities. "Raising awareness of all of these public education issues only makes for a better community" (Arwen, I). Ninety-eight percent of survey respondents and most of the scientists involved stated that they would attend *Science Rendezvous* in the future years and would recommend the S.T.E.M. festival to others.

The findings indicate that *Science Rendezvous Kingston* met its mandate by generating interest and enthusiasm for science among children and youth, and increasing awareness of the diversity of subjects encompassed by the word "science." The study also suggests that public events such as this S.T.E.M. festival help build a stronger community.

... continues on page 24

## REFERENCES

- Bell, P., Lewenstein, B., Shouse, A. W., & Feder, M. (2009). *Learning science in informal environments: People, places, and pursuits*. Committee on Learning Science in Informal Environments, Board on Science Education, Center for Education, Division of Behavioral and Social Sciences and Education, National Research Council of the National Academies. Washington, D.C.: The National Academies Press. Retrieved from, [http://www.nap.edu/openbook.php?record\\_id=12190&page=R1](http://www.nap.edu/openbook.php?record_id=12190&page=R1).
- Creswell, J.W. (2002). *Educational research: Planning, conducting and evaluating quantitative and qualitative research*. Upper Saddle River, NJ: Merrill Prentice Hall.
- Darling-Hammond, L. (2006). Constructing 21<sup>st</sup>-century teacher education. *Journal of Teacher Education*, 57(3), 300-314.
- Gee, J. P. (2001). Identity as an analytic lens for research in education. In W. G. Secada (Ed.), *Review of Research in Education*, 25(1), 105-107.
- Irby, M., Pittman, K., & Tolman, J. (2003). Blurring the lines: Expanding learning opportunities for children and youth. *New Directions for Youth Development*, 2003(97), 13-28.
- Lee, S. J., & Hawkins, M. R. (2008). "Family is here": Learning in community-based after-school programs. *Theory into Practice*, 47(1), 51-58.
- McMillan, J., & Schumacher, S. (2006). *Research in education: A conceptual introduction* (6<sup>th</sup> ed.). Boston, MA: Allyn & Bacon.
- Murphy, C., Ambusaidi, A., & Beggs, J. (2006). Middle East meets West: Comparing children's attitudes to school science. *International Journal of Science Education*, 28(4), 405-422.
- Nicotera, N., Cutforth, N., Fretz, E., & Summers Thompson, S. (2011). Dedication to community engagement: A higher education conundrum? *Journal of Community Engagement and Scholarship*, 4(1), 37-49.



... continued from page 23

## REFERENCES

- O'Meara, K., & Rice, R. E. (2005). *Faculty priorities reconsidered: Rewarding multiple forms of scholarship*. San Francisco, CA: Jossey-Bass.
- Penn, A., Ramsay, S., Dalgarno, N., & Colgan, L.E. (2012). *Learning math and loving it: ESSO family math*. Poster presentation at the QCOC Poster Conference, Kingston, Ontario, CA.
- Reynolds, A. J., & Walberg, H. J. (1992). A structural model of science achievement and attitude: An extension to high school. *Journal of Educational Psychology*, 84, 371-382.
- Silver, A., & Rushton, B. (2008). Primary-school children's attitudes towards science, engineering and technology and their images of scientists and engineers. *Education*, 3(13), 51-67.
- Silver, A., & Rushton, B. (2008). Primary-school children's attitudes towards science, engineering and technology and their images of scientists and engineers. *Education*, 3(13), 51-67.
- Springer, K. (2010). *Educational research: A contextual approach*. New Jersey: John Wiley & Sons.
- Warren, M. R. (2011). Building a political constituency for urban school reform. *Urban Education*, 46(3), 484-512.

## Conclusion

The research of the QCOC's three signature initiatives indicates that they are meaningful community engagement activities that impact educators, families, researchers, children and youth. The findings suggest that, through collaborative community-university partnerships, it is possible to (1) recruit, support and sustain the commitment of significant numbers of university faculty, staff and students to advance literacy and S.T.E.M. education through well-coordinated, high-quality, reciprocally rewarding activities and events; (2) have a positive impact on pre-service teacher education by building collaborative literacy and S.T.E.M. mentorship relationships with exceptional artists, scientists and museum educators; (3) improve the S.T.E.M. education experience of students by supporting teachers, parents, educators and families in informal settings, and through resource development; (4) legitimize the power of informal learning experiences and non-traditional teaching environments; (5) empower community-based workers to be action researchers as well as authors and consumers of empirical research; (6) influence public attitudes and beliefs about science, scientists and scientific research; and, (7) coordinate activities across institutions, departments, and organizations to advance literacy and S.T.E.M. education.



# Learning Math and Loving it!

ALEXANDRA PENN, *Loyalist College & Durham College*

Alexandra is currently teaching and developing new courses at Loyalist College and Durham College. She currently teaches career preparation, communication, and psychology courses and loves it! Alexandra completed her undergraduate degree at Trent University where she completed a double major in Biology and Geography. Alexandra continued her studies at Queen's University where she completed her Bachelor of Education and her Masters of Education. She currently lives in Toronto with her partner Ben and their kitten Binkley. In her free time Alexandra likes to go for hikes and spend time with her family!



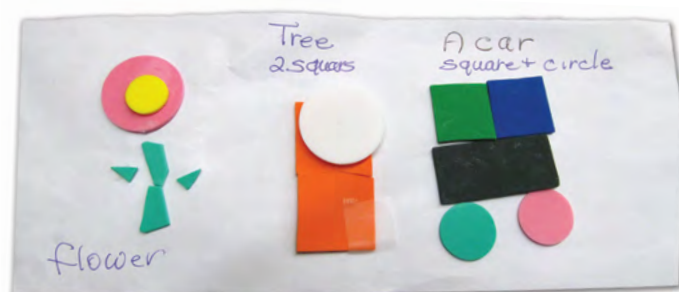
SUSAN RAMSAY, *Early Literacy, Kingston Literacy & Skills*

Susan has worked as an Early Literacy Specialist with Kingston Literacy & Skills for 13 years, offering emergent literacy workshops, programs, consultation, and resources to parents and professionals who have young children in their lives. A graduate of both Queen's University and St. Lawrence College, Susan's education and work experience blends knowledge of family systems, child development, adult education and early and emergent literacy development. Susan currently lives in Napanee with her husband Joe. Her three grown children are pursuing post-secondary education in Guelph Ontario, Paris France, and London England.



## Introduction

*The Early Math Strategy: The Report of the Expert Panel on Early Math in Ontario* published by the Ontario Ministry of Education in 2003 emphasized that, "success in mathematics in the early grades is critical. Early mathematics understanding has a profound effect on mathematical proficiency in the later years" (p.12). There are many factors which contribute to positive early mathematics experiences including support from home (Ministry of Education, 2003). Parents who build on children's inherent curiosity about math through concrete, playful situations can support children's knowledge and enthusiasm about math learning (Piaget, 1973). Rockliffe (2001) suggests that parents often lack depth of understanding about their child's math curriculum and that teachers' perceive parents as lacking the confidence necessary to help their children learn math. Rockliffe (2001) recommends that schools engage in strategies that increase parents' understanding and confidence in math education.



... continues on page 26

... continued from page 25

One way to do this is through play-based family literacy programs that celebrate and strengthen math knowledge and skills through fun intergenerational activities. (Frabotta, 2009). The ESSO Family Math program (Adams, Waters, Chapple, & Onslow, 2011) facilitated by Kingston Literacy & Skills: Family and Early Literacy, represents one such play-based family literacy program. This program was directed towards families with children between the ages of four and six. Trained facilitators guided parents and their children through math sessions using games, activities, songs, and stories which introduced new math concepts, reinforced math skills, and fostered enjoyment for mathematics.

The purpose of this study was to determine if family involvement in a play-based family literacy program influences the knowledge and perceptions of mathematics in the family unit. The following questions guided the research:

- 1 How does family involvement in a play-based family literacy program influence parents' knowledge of the five strands of the mathematics curriculum?
- 2 How does family involvement in a play-based family literacy program influence parents' knowledge of available mathematics resources?

## Methods

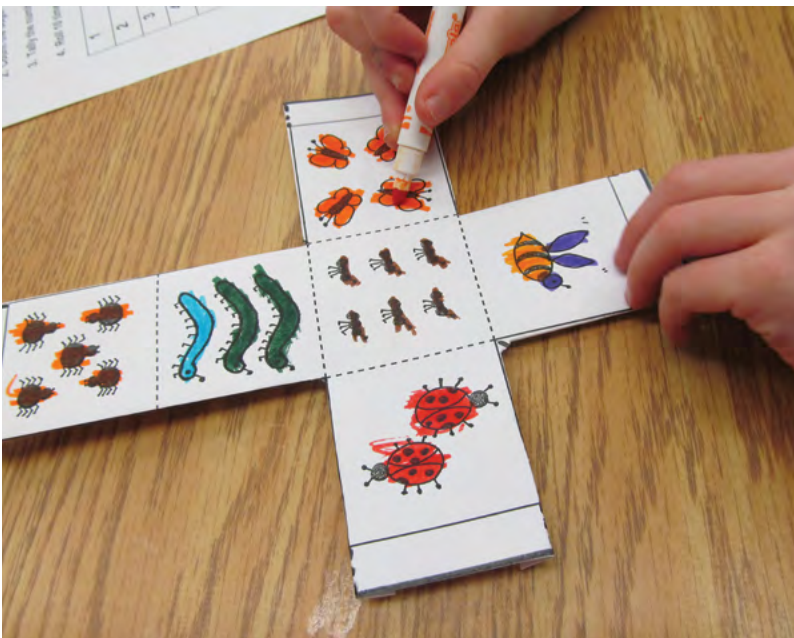
Fifteen families participated in Esso Family Math between February 16 and April 5, 2012. Qualitative data were collected from fourteen voluntary family units using pre- and

post-program interviews, weekly questionnaires and observations of the six family math sessions. Individuals' responses before and after the program were compared to determine if family involvement in a play-based family literacy program influenced parents' knowledge of the mathematics curriculum and awareness of available resources. The data were analyzed qualitatively using an inductive data analysis procedure which grouped data into broad themes to determine trends in the knowledge and perceptions of mathematics within the family unit.

## Results & Discussion

### *Parents' Knowledge of Mathematics Curriculum*

Prior to participating in the ESSO family math program all of the interview participants indicated that they were not familiar with the five major knowledge and skills strands in the Ontario mathematics curriculum: number sense and numeration, measurement, geometry and spatial sense, patterning and algebra, and data





management and probability. Although a few parents indicated they had seen the five strands on report cards or on the school website, they stated that they “really don’t know a lot in terms of the curriculum, unfortunately” (R’s pre-interview, 19). At the end of each ESSO family math night the facilitators discussed how the program’s activities fit into the five mathematics strands in the Ontario curriculum. Based on observations of the program, comments on the questionnaire, and post interview responses, parents’ and caregivers’ understanding of the curriculum was found to improve. Most of the parents and caregivers expressed after the program that they “...understand the curriculum more and how it is being taught. I feel a little more confident that I can help her out” (L’s post-interview, 30). Overall, parents’ and caregivers’ understanding and comfort with the Ontario mathematics curriculum was found to increase after participating in the ESSO family math program.

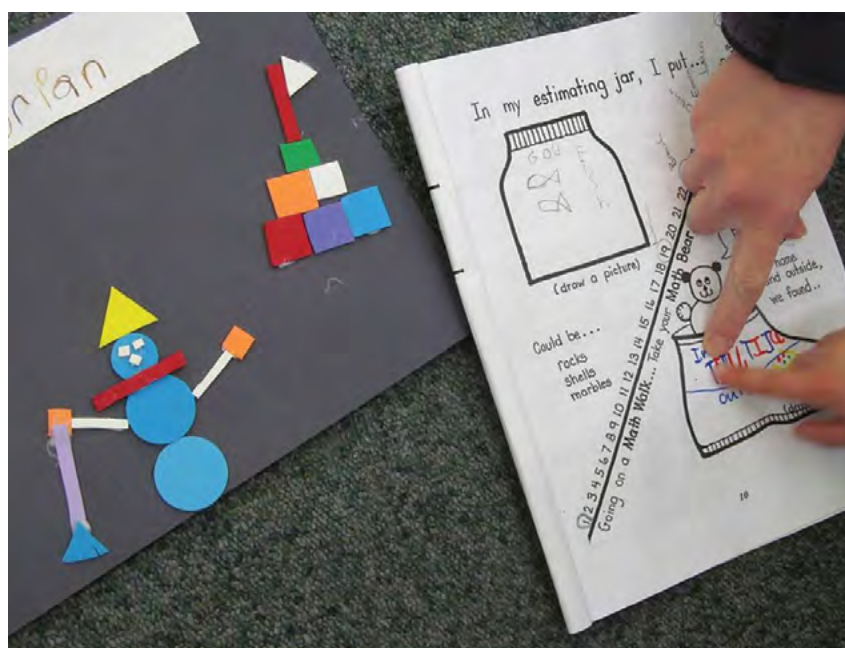
### ***Parents’ Knowledge of Mathematics Resources***

Prior to participating in the ESSO Family math program, all of the parents described using store bought resources such as books, cue cards and games to help their children learn mathematical concepts. Following the completion of the program very few participants discussed using store bought resources. Parents expressed the belief that almost anything can be used to help their children learn math. When one parent was asked what resources she would use in the future to help her child, she explained, “I mean you can use anything around the house. I think we have a lot of the materials already to do most of it” (B’s post-interview, 42). After participating in the play-based family literacy program participants’ beliefs about what could be used as a mathematical resources was found to expand from store bought books and tools to everyday items found around the home.

### **Implications**

Participation in this family math program positively influenced parents’ knowledge of math curriculum and math resources. Though future studies would be needed to determine if involvement in family math programs similarly impacts children’s knowledge and perceptions about math, the results of this study do have implications for children, parents, and educators.

... continues on page 28



... continued from page 27

## REFERENCES

- Adams, L., Waters, J., Chapple, N., & Onslow, B. (2011). Ezzo Family Math: Resources for JK, K & Grade 1 Children and their Parents. Ezzo Family Math Centre. Retrieved from <http://www.edu.uwo.ca/ezzofamilymath/Resources/ycresources2011.pdf>
- Edmunds, G., Onslow, B., Chapple, N., Waters, J. & Adams, L. (2005, Jan) Increasing parental sense of efficacy for facilitating their children's mathematical development. Paper presented at the Third International Conference on Education, Honolulu, HA.
- Hoover-Dempsey, K., & Sandler, H. (1997). Why Do Parents Become Involved in Their Children's Education? *Review of Educational Research*, 67(1), 3-42.
- Frabotta, S. (2009). Fun-Filled Family Literacy Nights. *The Delta Kappa Gamma Bulletin*, 75(4), 19-22.
- Ministry of Education. (2003). Early Math Strategy: The Report of the Expert Panel on Early Math in Ontario. Retrieved from <http://www.edu.gov.on.ca>
- Piaget, J. (1973). *To understand is to invent: The future of education*. New York: Grossman.
- Rockliffe, F. (2001). Parental involvement in mathematics education in a Canadian elementary school. Paper presented at the European Research Network about Parents in Education, Rotterdam, Netherlands.

Piaget's work in child development would suggest that the implications of this study for children are well grounded (Piaget, 1973). Children who are exposed to math concepts through play in their daily routines, story times, singing and conversations at home are less likely to experience math as an isolated subject or school-only activity (Piaget, 1973). When math is woven into children's home and school contexts, children's natural curiosity and enthusiasm to understand their world through a mathematical lens is more likely to be affirmed and strengthened (Piaget, 1973).

Similarly parents, who through the family math program have experienced positive changes to their knowledge base and to their attitudes about math learning, are more likely to see themselves as a competent team player in their child's education (Edmunds, Onslow, Chapple, Waters, & Adams, 2005). This self-perception could be invaluable to their children who want homework help, or who want to explore more fully the topics introduced at school. This self-perception could also play a role in strengthening parents' connection to their children's schools (Hoover-Dempsey & Sandler, 1997). If parents lack depth of curriculum knowledge and or the confidence to support their children's math learning at home as this study and Rockliffe (2001) suggests, school administrators and educators across Ontario may want to analyze their ongoing strategies and programs for helping family members become stronger, more knowledgeable, and more confident team players in their children's learning. Knowing that family math programs, such as ESSO Family Math, can set the stage for increasing parents' knowledge and confidence to support math learning at home, schools and school boards should consider how ongoing, sustained collaborations with community partners could support education within the family as well as within the classroom.

*Special thanks goes to all of the families who participated in this study, Jennie Hill and Anne Jackson (co-facilitators), Kingston Literacy & Skills, Queen's University Community Outreach Centre, Imperial Oil Foundation, Mike Blackburn, Darlene Armer, and Lennox & Addington Resources for Children for making this project possible.*



# The Power of Informal Science Learning

MARILYN FENICHEL, *Principal of Cassell & Fenichel Communications, Washington, D.C.*

*With more than 30 years of communications experience, Marilyn Fenichel has a flair for taking complex manuscripts and turning them into successful products for a lay audience. Marilyn is a science and education writer and editor and counts among her clients the American Association for the Advancement of Science, American Association for the Advancement of Science, the National Science Foundation, the National Academies, the Society for Neuroscience, and Discovery Education. She is co-author of the 2010 book *Surrounded by Science: Learning Science in Informal Environments*, published by the National Academies Press. Marilyn graduated cum laude from Bryn Mawr College with an A.B. in English. She is a member of the National Association of Science Writers.*



**W**hen I was a child, dinner table conversation was devoted to science. My father, a biochemist, would come home from work excited about what he had done in the lab that day. His interests ranged from blood studies to diabetes to cancer. We would all listen attentively, with my mother, a former lab technician, asking pointed questions, probing the underpinnings of my father's research.

Those evening conversations laid the groundwork for my lifelong interest in science. Almost by osmosis, I absorbed the language of science, becoming comfortable with the terms used to explain how research is conducted. I never studied science formally, but I continued my informal education by visiting science museums, reading articles about new discoveries, and attending lectures held in the community.

My experience is not unusual. By some estimates, people only spend about 9% of their lives in school. For this reason, much learning about science takes place in informal settings, which include walks in the woods, personal hobbies, and surfing the Web; as well as visits to museums, aquariums, and zoos, and participation in after-school and summer programs, clubs, and citizen science activities. Over the past 40 years, the value of these varying learning experiences has been documented in a growing body of research.

In 2010, the National Academies Press, under the auspices of the National Research Council of the National Academies, published *Surrounded by Science: Learning Science in Informal Environments* (by Marilyn Fenichel and Heidi A. Schweingruber), a compilation of this expansive research designed for practitioners in the field. The book describes the kinds of learning that take place in different settings. What's particularly exciting is that the common features representing the hallmark of informal learning are identified.

## Keys to Learning in Informal Settings

Several features set apart informal learning from the way we learned in school. For one thing, participants are encouraged to engage with the experience in as many ways as

*... continues on page 30*

... continued from page 29

possible—physically emotionally, and cognitively. As a result, participants often interact directly with phenomena, whether it's examining rocks at a natural history museum, feeling the rough shell of a tortoise at a nature center, or collecting leaves at a nearby wooded area. What's more, these interactions are driven by the learner's own unique interests, and they are being pursued voluntarily. Above all else, a participant, no matter how young or old, has control over whether and how they engage and learn.

Emphasizing choice and learning simultaneously may appear contradictory, but they co-exist because of another important feature—the skill of designers who develop informal learning spaces. They understand that making informal experiences interactive and providing multiple entry points for engagement help draw participants in. *Cell Lab*, an exhibit at the Science Museum of Minnesota, takes these ideas to the next level. Composed of a series of eight wet-lab biology experiences, participants do real science in a safe environment. Investigations include taking cells from the inside of their cheeks and making a slide to view them under a microscope and testing whether hand soap, bleach, or sanitizers are the most effective against a common bacteria. To make the experience even more authentic, everyone entering *Cell Lab* must put on a lab coat, goggles, and gloves. Not only does the laboratory uniform protect the museum visitors, it also makes them feel part of the scientific community.

*Cell Lab* has been open for more than ten years, and it has been studied extensively. Research has shown that learning takes place within the context of an enjoyable experience. As one father notes, "*Cell Lab* is my favorite because it's fun to mess around with all this stuff and do little experiments for yourself rather than watch someone else do it. We visit all the time, and even though the experiment is the same, the kids get just as excited" (Korn, 2003).

Equally important as interactivity is the role of conversation and social interactions during informal learning experiences. In fact, even discussions that viewers have while watching television have been shown to prompt learning. In one study, researchers Margaret Haefner and Ellen Wartella (1987) found that through explanations and laughter, older siblings could help their younger brothers and sisters understand plot elements in educational programming. Similarly, Robert Reiser and his colleagues (1984) found that when adults intervene to help their children learn numbers and letters, they remember them better than those who were not coached. Studies of conversations that take place during museum trips have come to virtually the same conclusions.

In longer informal programs, such as Cornell Lab of Ornithology's Project FeederWatch, volunteers learn just as much sharing their findings about the birds they've observed with their science mentors as they do from their solitary bird-watching experiences. Some volunteers gained so much expertise that they were invited to contribute to scientific journals. In this community, publication is a clear sign that an individual has been accepted as a peer—no small accomplishment.

*Equally important as interactivity is the role of conversation and social interactions during informal learning experiences. In fact, even discussions that viewers have while watching television have been shown to prompt learning.*

### The Emotional Side of Learning

Another interesting facet of the research on learning in informal settings is its acknowledgment of the role of emotions. According to the literature, not only do emotions make learning relevant and meaningful, they also help determine what is retained and how long it is remembered (National Research Council, 2000). Furthermore, the more interested people are in a topic, the more motivated they are to pay attention, seek out new



This piece, **Bowl of Squash**, by James Cassell, illustrates for me the power of informal science learning. Just as different colors are layered to form the image of a bowl, so learning science informally builds to create new meaning for participants.

*... continues on page 32*

... continued from page 31

## REFERENCES

Korn, R. (2003). *The Science Museum of Minnesota: Cell Lab Summative Evaluation*. Retrieved from: [http://www.informalscience.org/evaluations/report\\_174.pdf](http://www.informalscience.org/evaluations/report_174.pdf).

Haefner, M.J., and Wartella, E.A. (1987). Effects of sibling covieing on children's interpretations of television programming. *Journal of Broadcasting and Electronic Media*, 31(2), 153-168.

Reiser, R.A., Tessmer, M.A., and Phelps, P.C. (1984). Adult-child interaction in children's learning from *Sesame Street*. *Educational Communications and Technology*, 32 (4), 217-233.

National Research Council. (2000). *How People Learn: Brain, Mind, Experience, and School* (expanded ed.). J.D. Bransford, A.L. Brown, and R.R. Cocking (Eds.) *Committee on Developments in the Science of Learning*. Washington, DC: National Academy Press.

challenges, and build on what they already know. Not surprisingly, cultivating interest and motivation is a high priority for many informal science educators, from those who work on short-term projects such as museum exhibits to individuals heading up long-term after-school science initiatives.

A project set in a homeless shelter in the South Bronx is a powerful illustration of this point. The project leader was charged with working with the teens living in the shelter to design a program to help the community. After much discussion, the group decided to use a vacant lot to build an urban garden. The teens were given a lot of freedom to pursue the project in their own way, and over time, it took on a life of its own. They became more and more engrossed in the activity, seeking out experts in the local community to help them with their plans and persevering until their vision began to take shape. The harder they worked, the greater impact they had on their community, and the more motivated they became to do even more. Through their informal science project, the teens found new meaning in their lives and felt empowered to change their community by using science to reduce violence, create beauty, and bring together disparate members of their neighborhood.

Just as the New York teens benefited from their informal science experiences, I look back on those science-based dinner table conversations and see them as life-changing. Exposure to science at an early age in a relaxed setting gave me confidence to pursue difficult topics, even those I know little about. And it led to my career as a science writer. Through my work, new doors of inquiry have opened up for me, enriching my life in numerous ways.

My hope is that science can be incorporated into everyday life for more people of all ages and from all parts of society. Science can offer all of us the opportunity to feel comfortable learning about our world and ourselves.

# Inspiring the Next Generation of Scientists, Innovators and Engineers

NANCY BOYER, *Manager of Research and Evaluation at FIRST Robotics, Manchester, NH*

*For Inspiration and Recognition of Science and Technology (FIRST) is a non-profit organization providing STEM programs for youth ages 6–18, around the world. In her capacity as Manager of Research and Evaluation for the organization, Nancy manages the internal and external evaluations and data collection efforts of FIRST. Nancy has a master's degree in social work and a PhD in sociology and social work. Over the last 15 years, she has worked in non-profit settings conducting program development, grant writing and fund development, and program evaluation and research. Nancy teaches research methodology and statistics courses for the Master of Social Work program at Boston University.*



Children are born with a natural curiosity to discover the world around them. I have observed toddlers and preschoolers repeatedly attempt to build a tower of blocks that doesn't topple, fascinated with how a stone thrown in a puddle creates ripples, or experimenting with sticks, rocks, or leaves to change or stop the flow of water streaming down a driveway. Children at a very young age use concepts of STEM as they discover the world around them, unlocking the puzzle of how things work. Yet, after children start formally learning about science and math in school, this natural interest and curiosity declines and, in some cases, vanishes entirely. Research indicates that by the time children reach eighth grade, only 20% of them are interested in science and math and by twelfth grade this number falls to 16% (Stephens, 2010). How do educators, parents, and professionals in STEM (science, technology, engineering, and math) maintain and cultivate a child's natural curiosity in science and math? Is there a way for science and mathematics to compete with the excitement of other interests such as sports and entertainment? How do we inspire the next generation of scientists, engineers and innovators? Dean Kamen, founder of FIRST® (For Inspiration and Recognition of Science and Technology®) has created an organization that aims to solve this problem by engaging kids in exciting robotics-based challenges that promote STEM learning, discovery and innovation.

To inspire young people to become science and technology leaders has been the mission of FIRST since its inception in 1989. FIRST offers four STEM-based programs for youth ages 6–18: Junior FIRST® LEGO® League (Jr.FLL®), FIRST® LEGO® League (FLL®), FIRST® Tech Challenge (FTC®) and FIRST® Robotics Competition (FRC®). Serving over 300,000 youth worldwide, the FIRST Progression of Programs for K-12 offers project-based, experiential learning that actively engages youth in STEM. Youth work on teams with adult coaches and mentors to accomplish a specific science-based or engineering challenge. The programs are located in a variety of settings including schools, universities, industry, youth organizations, and community venues. They may be part of a class or conducted as an out-of-school activity.

... continues on page 34



... continued from page 33

### How does *FIRST* work?

Our programs incorporate best-practice strategies for engaging youth and cultivating interest in STEM such as:



- *Providing relevant and real challenges:* Each of the four programs is based on a specific challenge that changes each year. In Jr. FLL and FLL, youth research some of the top problems that face scientists and engineers today and, in FLL, develop specific innovative solutions to those problems. In FTC and FRC, participants respond to a robotics-based challenge through real-world circumstances (e.g., time constraints, cost constraints and need for collaboration).
- *Providing an opportunity for hands-on experiences:* All four FIRST programs require participants to experiment, manipulate, create, and actively work on the challenge. Jr. FLL participants build simple, working, machines; FLL participants build autonomous robots programmed to accomplish as many “missions” as possible in under three minutes; FTC and FRC participants build robots that can accomplish the challenge in a competitive forum. Hands-on experiences go beyond robot-building. Participants also actively work on publicity, marketing, fundraising, writing, and presentation skills.
- *Youth engaging in STEM challenges through teamwork and group learning:* Teams work together to solve the challenge and in the process they learn key 21st century work skills such as problem solving, time management, communication, and conflict resolution. Youth develop leadership skills and self-confidence. The result is a sense of belonging and team identity.
- *Teams working with experienced mentors:* Adult coaches and mentors work with teams as they participate in the program challenge. They serve as role models, bringing STEM careers and professions to life.
- *FIRST Values are promoted throughout the experience:* FIRST encourages all participants—adult and youth—to live and work with Gracious Professionalism® (demonstrating respect for others, being a good sport, and sharing what they learn). Coopertition® (competing like crazy, but also helping the other teams) and Gracious Professionalism are two key values that the FIRST community embodies.
- *Programs culminate in high energy tournaments:* FIRST programs offer expos or robotics tournaments for Jr. FLL and FLL where youth present their ideas, solutions and accomplishments. In FTC and FRC, the robotics competitions allow participants to celebrate their successes with a community of peers.

Research suggests that engaging youth interest in STEM at young ages is more likely to lead to interest in STEM careers than math or science courses (Maltese & Tai, 2011). Further, it is student interest and self-confidence in STEM that leads to a greater likelihood of a STEM career than achievement in coursework or on standardized tests (Maltese & Tai, 2011). Recent formal evaluations of FIRST conducted by the Center for Youth and Communities at Brandeis University have found that through participation in FIRST, youth are more likely to attend college full time, major in science or engineering and are more likely to pursue a STEM career than a national sample of students (Melchior, Cohen, Cutter & Leavitt, 2005). Youth participants in FLL, FTC and FRC note that as a result of participating in FIRST, they are more interested in learning about science and technology, more interested in going to college, and more interested in a career that uses science and technology (Center For Youth and Communities, 2011; Melchior, Cutter & Deshpande, 2009). Further, across all programs, FIRST youth participants are developing work and life skills such as teamwork, problem solving, time management, and communication skills as a result of their work on a FIRST team (Center For Youth and Communities, 2011; Melchior, Cutter & Deshpande, 2009). In a recent survey of FIRST Alumni conducted by FIRST, it was found that 90% of Alumni are currently in a STEM field as a student or professional. Alumni note the long lasting impacts of FIRST:

*"FIRST got me interested in electronics and engineering. It helped me to develop skills in teamwork, problem solving, and valuable technical abilities. I honestly believe that FIRST is one of the reasons that I am in the field I am today, and has been a major contributor to my success in and after high school. Additionally as a woman in engineering, it has helped me to both learn how to work well in a male dominated field and get other women interested in STEM-based careers."*

*"FIRST has really helped me to dial in on a specific area of engineering I wanted to do and it has also increased my interest in a STEM related career."*

*"FIRST was instrumental in shaping and preparing me for my education and career. FIRST provides a means for developing countless essential skills from the highly technical such as using CAD programs and wiring circuits and using tools to the more soft skills such as leadership, presentation and communication, organization, teamwork etc. My experiences with FIRST have given me a huge advantage over my classmates coming into college. In FIRST we were given the opportunity to engage in real, hands on engineering problem solving."*

*"FIRST got me interested in electronics and engineering. It helped me to develop skills in teamwork, problem solving, and valuable technical abilities. ... "*

*... continues on page 36*

... continued from page 35

## REFERENCES

Center for Youth and Communities. (2011). *Cross-Program Evaluation of the FIRST Tech Challenge and the FIRST Robotics Competition*. Waltham, MA: Brandeis University.

Maltese, A. & Tai, R. (2011). Pipeline persistence: Examining the association of educational experiences with earned degrees in STEM among U.S. students. *Science Education*, 95(5), 877-907.

Melchior, A., Cohen, F., Cutter, T., Leavitt, T. (2005). *More than Robots: An Evaluation of the FIRST Robotics Competition Participant and Institutional Impacts*. Waltham, MA: Center for Youth and Communities, Brandeis University.

Melchior, A., Cutter, T., Deshpande, A. (2009). *Evaluation of the FIRST LEGO League "Climate Connections" Season (2008-2009)*. Waltham, MA: The Center for Youth and Communities, Brandeis University.

Stephens, R. Testimony to the House Science and Technology Committee, Subcommittee on Research and Science Education. Retrieved February 4, 2010 from, [http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/020410\\_Stephens.pdf](http://science.house.gov/sites/republicans.science.house.gov/files/documents/hearings/020410_Stephens.pdf)

Evaluation findings suggest that *FIRST* is having a positive impact on cultivating the interest of youth; however, additional research is needed to better determine the longer term impact of *FIRST*—how *FIRST* influences youth interest and motivation in STEM, education, and career choices. To address these questions, *FIRST* has invested in a multi-year longitudinal study tracking the outcomes of new FLL, FTC and FRC participants against a non-*FIRST* comparison group. Preliminary findings from year one are expected in the fall of 2013.

Until we live in a world where scientists, engineers and inventors become the heroes of our youth, *FIRST* will continue to work towards transforming culture by “creating a world where science and technology are celebrated and where young people dream of becoming science and technology leaders” (Dean Kamen, Founder). For more information on *FIRST*, please check out our website: [www.usfirst.org](http://www.usfirst.org).



# Science as Art in Contemporary Theater

STEPHEN ABBOTT, *Middlebury College, Middlebury, VT*

*A graduate of Colgate University (BA, 1986) and the University of Virginia (PhD, 1992), I have spent the majority of my professional life as a professor of mathematics at Middlebury College, with one-year appointments at Virginia, Saint Olaf College and Cambridge University. My early research was in functional analysis and operator theory. Eventually, I shifted my focus to real analysis and wrote an introductory text on this subject. More recently, I have developed a strong interest in the relationship between mathematics and art, specifically focusing on contemporary theatre. I am currently co-editor of Math Horizons, a quarterly journal published by the Mathematical Association of America.*



In 1998, British playwright Michael Frayn wrote *Copenhagen*, a play about the 1941 encounter between Danish physicist Niels Bohr and his former student Werner Heisenberg who was put in charge of the Nazi nuclear program at the start of World War II. *Copenhagen* was by no means the first time a play had engaged the ethical questions surrounding the atom bomb, but it was groundbreaking in one regard. Instead of soft-pedaling the science, Frayn took the quantum mechanics head on, incorporating substantial discussions of uncertainty and complementarity into the dialogue as well as weaving these same scientific principles into the structure of the play.

The results were dazzling. *Copenhagen* was embraced by audiences and critics, and was eventually made into a film by the BBC. At about the same time that *Copenhagen* was winning the 2000 Tony Award for Best Play, David Auburn's *Proof*, a play about a mentally ill mathematician and his daughter, was winning over audiences of its own and garnering a Pulitzer Prize. Just for good measure, the film *A Beautiful Mind*, which chronicles the life of Princeton mathematician John Nash, won the Academy award for Best Picture the following year.

What should we make of the sudden popularity of mathematics and science? What was it that caught the collective imagination of playwrights and directors, and what has happened in the decade since?

When cosmologist Stephen Hawking wrote his 1988 best-selling nonfiction book, *A Brief History of Time*, he was warned that every equation he included would reduce his readership by half. Hawking took the advice to heart and included only one ( $E=mc^2$ ). To be fair, Hawking's book is still quite technical, but it was supposed to be. People expected as much from a book about the Big Bang; they did not expect it from a play, at least not in 1988.

... continues on page 38



... continued from page 37

In the same year that Hawking's book was published, Tom Stoppard's new play *Hapgood* opened in London. Stoppard had been a leading playwright since the 60s, and expectations were high. On the surface, *Hapgood* was a spy-thriller about a female British intelligence officer faced with the possibility of a mole among her agency. Below the surface, Stoppard's script was actually about the inherently ambiguous nature of human personality—how all of us are really double agents, capable of inhabiting one of several personalities depending on the particular experiment in which we are cast. The central metaphor Stoppard uses is the wave/particle duality of light. "Somehow light is continuous and also discontinuous," the Russian scientist explains. "The experimenter makes the choice. You get what you interrogate for."

The analogy is provocative, but it was also ahead of its time. To make it work, Stoppard needed to explain a fair bit of quantum theory to his audience, and critics thanked him by characterizing his new play as an impenetrable lecture. "It would need a seeing-eye dog with A-level physics to guide most of us through what was going on," was how one reviewer summed it up.

It is all the more remarkable, then, that five years later Stoppard returned to mathematics and science as source material for his play *Arcadia*. Struck by his reading of James Gleick's *Chaos*, Stoppard created a narrative about a young girl living at the beginning of the nineteenth century who stumbles onto the late twentieth century ideas of chaos theory and fractal geometry. In fact, the play consists of characters from past and present, with the modern day characters predominantly engaged in researching the antics of the nineteenth century cast. Not coincidentally, the earlier period sits at a transitional point in history, between the Enlightenment and the Romantic era, and one way to view the entire play is as an exploration of the tension between romantic and classical ideas, broadly defined. The play is full of allusions to art and architecture, but mathematics and science are frequently center stage. In Stoppard's telling, fractal geometry represents a romantic counterpart to classical Euclidean geometry. Likewise, Newton's laws are classical physics while the second law of thermodynamics is given a "romantic" identity by describing it with double entendres such as "the action of bodies in heat."

The density of scientific ideas is higher in *Arcadia* than it is in *Hapgood*, but whereas *Hapgood*'s author was berated for "leaving his homework all over the stage," *Arcadia* was immediately celebrated as Stoppard at the top of his game—a perfect marriage of comedy and ideas where the science is integral to the storytelling. By focusing on the chasm between science and the humanities, Stoppard actually found a way to bring the sides closer together. The pompous Byron scholar is given his moments to pontificate. "A great poet is always timely," he howls, "a great philosopher is an urgent need. There's no rush for Isaac Newton. We were quite happy with Aristotle's cosmos. Personally, I preferred it. Fifty-five crystal spheres geared to God's crankshaft is my idea of a satisfying universe."

The bluster makes for good theater, but the rebuttal is where we hear the playwright's real convictions. In arguably the play's most important speech, Hannah (the modern-day

Struck by his reading of James Gleick's *Chaos*, Stoppard created a narrative about a young girl living at the beginning of the nineteenth century who stumbles onto the late twentieth century ideas of chaos theory and fractal geometry.



historian) tells Valentine (the mathematician) that “comparing what we are looking for misses the point. It’s wanting to know that makes us matter.”

The success of *Arcadia* must have had some effect on Michael Frayn’s willingness to incorporate so much physics into his drama about Bohr and Heisenberg’s fateful wartime meeting. This historical event, which effectively ended their friendship, is shrouded in mystery. “Why did he come to Copenhagen?” Bohr’s wife asks in the opening lines of the play. Was it for advice? For his mentor’s blessing? For forgiveness?

What Frayn realized was that quantum mechanics not only supplied the best answer but also the best mechanism for how to tell the story. The quantum world does not come equipped with the concrete, deterministic reality we associate with falling apples and bouncing billiard balls. There is a fuzziness to atomic particles that requires a probabilistic description—the best we can do is provide a so-called “wave function” that represents the distribution of outcomes obtained by repeating an idealized experiment over and over again. Frayn’s idea was to have Bohr and Heisenberg rerun the experiment of Heisenberg’s visit multiple times, each time illuminating some new aspect of the wave function governing Heisenberg’s motivations. Why did Heisenberg come to Copenhagen? We gain bits of insight with each measurement, but in the end, as with any quantum measurement, there is a core of unresolvable uncertainty.

Here again we are confronted with the revelation that the divide between science and the humanities is a superficial one. This, in fact, may be the most important message to come out of the success of plays like *Arcadia*, *Copenhagen*, and *Proof*. Once it was clear that half of the audience would not get up and walk out with each mention of an equation, playwrights flocked to the scientific end of the intellectual spectrum in search of new characters, questions, and metaphors. The last decade has seen a proliferation of plays about science: Isaac Newton, Charles Darwin, Albert Einstein, and Alan Turing have appeared in multiple scripts, as have ethical debates about fetal diagnostics, cloning, and climate change.

And what has science and mathematics received in return? Apart from some positive PR (which is nothing to sneeze at), we are reminded that all knowledge is self-knowledge. Looking at science through the artist’s lens is crucial for understanding how intimately connected scientific progress is to human progress. The stage has also cast a generous light on the aesthetic nature of mathematics and science. Typically, the argument for increased attention to STEM subjects is based on their utility, but sometimes inspiring a sense of wonder is reason enough. In this regard, science is as artful as Shakespeare.



**Arcadia**

... continues on page 40

#### REFERENCES

Hawkins -1988 *A brief history of time*

*Frayn*, Michael Copenhagen play 1998

David Auburn — *proof* (play)  
*A beautiful mind* (movie)

Tom Stoppard, *Hapgood* (play)

Tom Stoppard, *Arcadia* (play)

James Gleick, *Chaos* (book)



*Arcadia*

# On the Diversity of Research Partnerships and their Challenges in Social Science

LUCIE DUMAIS, *L'Université du Québec à Montréal*

*Professor at l'École de travail social de l'Université du Québec à Montréal and co-director of the Laboratoire de recherche sur les pratiques et les politiques sociales (LAREPPS). Dr. Dumais is a sociologist with extensive interdisciplinary, university-level teaching and research experience in social policy, health and labour policy (sociology, social psychology, ergonomics, occupational health and social work) and has extensive partnership experience (with corporations, unions, community groups and public institutions).*



**F**or the last 20 years, my university level research work has led me to collaborate directly with organizations in the field. For a social science researcher, empirical field work presents a pleasant detour that allows one to directly observe the daily social life of people, groups and organizations. It helps, in fact forces the researcher to stay connected to reality. It all comes down to an opportunity to go test hypotheses and reexamine explanatory theories which is at the heart of the scientific method. However, if one goes to the trouble, there is more to field work. When empirical work intersects with collaboration, such as in research partnerships, field work requires us to meet our subjects' demands as opposed to imposing a study designed in advance. That is how research puts itself to the service of the public that finances it, happens in concert with the subjects it studies, and democratizes itself: it starts giving back to society, in the largest sense, and in its most beautiful social, cultural and economic diversity.

While I see virtue in research partnerships; given that they bring the university community closer to social and political agents, they also risk instrumentalizing research beyond what is reasonable. Boundaries are therefore important. As a university researcher, I heartily champion freedom of research and the necessity of basic research, both in natural and social science. I will therefore discuss, through a few examples, the breakthroughs that have allowed me to undertake collaborative research, as well as the lessons that I have learned. They have led me to identify parameters that I believe are essential to these efforts.

In the 1990s, two research projects on occupational health, done in partnership with local unions, led to differing levels of collaboration and impact. Why? In the first case, back problems were arising amongst the employees of an industrial bakery, and an

*... continues on page 42*

... continued from page 41

*In the second study, which took place in a municipality, the local union, in conjunction with the municipal work equity committee, supported research aiming to study musculoskeletal problems amongst blue collar workers as well as the integration of women in public works.*

ergonomic analysis of their daily work proved itself useful when it came to identifying causes and preventative measures. During the study, the participation of the general manager at the factory, which was part of a network of food production subsidiaries, was exemplary. As a representative of the managing body on the company's health and safety committee, he took on the role of research partner and served as the intermediary between the union and the national manager. The factory manager's concern with respect to the musculoskeletal problems long time employees were facing was very clear. In this favorable context, the research team also had the opportunity to study gender based division of labor by connecting ergonomics and sociology. The study allowed us to better understand the positive and negative facets of factory work, as well as the competencies developed by men and women in the positions they held in this labor force. Nevertheless, at the conclusion of this study, the partners and research team were caught short by the shutdown of the factory (one of the most obsolete amongst the subsidiaries). Sociologically, studying the conditions under which the unionized personnel was transferred would have been pertinent, both from the practical and from the theoretical side. However it was not possible to pursue this opportunity.

In the second study, which took place in a municipality, the local union, in conjunction with the municipal work equity committee, supported research aiming to study musculoskeletal problems amongst blue collar workers as well as the integration of women in public works. The partnership with the union, however, did not correspond to true engagement on their part. It did allow for the employees' time to be freed up in order to participate in data collection (direct observation, interviews, and meetings between partners and researchers), but overall, there was little interest in the research being conducted. For the research team, the results brought to light aspects of the daily reality of blue collar work and of the union-managerial relationship, but the research itself did not necessarily have any impact on the organization or influence in any way the reality faced by the employees, the managers and the union officers. It seems to me that this example highlights a discrepancy between the discourse and the reality of collaborative research and its effects on real actions. On the other hand, from the point of view of traditional collaborative research, we have to admit that monographic knowledge clearly emerged from the effort.

In the year 2000, my reorientation into social economics led me to "test" research partnerships in a different way. The context was my engagement with a different set of actors on the health and social services landscape, by which I refer to not-for-profit organizations and public institutions, which adopt different positions when it comes to issues of access to public services. I will highlight some of the other aspects of research partnerships by relating two of these experiences.

In 2004, at the request of an organization facilitating the integration of disabled people in the workforce, itself supported by an association of parents and financially supported through governmental funding, the research team was to evaluate a pilot project working

with young autistic adults. During this research project, which was considered a success by the research partners due to the findings, new knowledge, and resulting discoveries, several problems nevertheless appeared and provided important lessons when it comes to setting future parameters. First of all, it must be made clear that the research project benefitted from great collaboration from all partners, notably when it came to collecting information and holding discussions, which are important aspects of any such project. Now, when it came to evaluation, the partnership model had not completely voided the organization's fear of being 'negatively' evaluated. However, the presence of an intermediary, in this case an agent of the Disability office, somewhat eased such tensions and helped to encourage the evaluation process. That being said, the context through which this project (labeled as experimental) had been implemented placed an undue pressure on the process, for there were too many expectations that the project 'should work': the young adults' parents had pinned all their hopes on its success and the financial support of the pilot project was going towards staff salary in the said organization, which thus saw itself in a very vulnerable situation. In the end, the results of the study were discussed between the partners before being made public, but, in the longer term, they were used by each party in its own way. For example, some of the results were seen as mixed by some partners and positive by others; and the usage of the term 'intervention model' by the organization did not seem very appropriate to the researchers. The outcomes of research done in partnership, it goes with saying, always serve a latent purpose to the actors concerned. But, they also deserve to contribute to societal discourse, beyond the direct interest of the partners; in this example, the findings should have contributed to forming a critical theory of social policy when it comes to the integration of disabled people, because beyond militant slogans and legitimate aspirations, social research seeks to guide the functioning of social institutions, to elucidate who we collectively are, and to work patiently towards the complex elaboration of a social policy.

In 2006, this time at the request of a community facilitator, a group of militant leaders of local organizations were invited to participate in a research partnership, which once again included an evaluation aspect. On the positive side, in this short time, the partnership facilitated access to data and sharing results. On the negative side, the issues and tensions were similar to those facing the organization in the preceding example, but took place on a neighborhood-wide scale: these included fears of being put under the researchers' lens, vulnerable positions (or feelings thereof) for certain organizations, and varied use of the results by the different partners. The particularity of this research project was the absence of an intermediary between the researchers and the actors in the field; the two senior researchers, who were known in this environment, fulfilled this role.

Overall, the research partnerships I have contributed to are not a representative sample, far from it. However, they illustrate how diverse research partnerships can be and allow me to draw some lessons. Conducting research in partnership presents a new methodology for university researchers, and opportunities for social actors to reap benefits

*First of all, it must be made clear that the research project benefitted from great collaboration from all partners, notably when it came to collecting information and holding discussions, which are important aspects of any such project.*

*... continues on page 44*



*... continued from page 43*

from public research, but it also brings some difficulties and some risky bets. Amongst the boundaries or criteria that could lead to a framework for the future, I hold on to the following: are the actors sufficiently dedicated to producing new knowledge? Is there, amongst the partners, someone who can take on the role of intermediary? Is the purpose of the research project (evaluative, descriptive or explicative) a shared goal? And finally, will the funding model offer sufficient freedom? Most of my collaborative research endeavors would not have taken place if the great funding agencies, whether on the federal or provincial (Québec) level, had not put in place programs in support of partnerships, and in my personal case, if the Université du Québec had not mandated its faculty members, thirty years ago, to dedicate part of their work to the serve the collectivity.



***A moment of bliss. Contemplating Venice at dusk, one part of humanity's heritage.***

# Interpreting Science for the Public, Fostering Critical Thinking and Separating Sense from Nonsense

JOE SCHWARCZ, *Director, Office for Science and Society, McGill University*

*Joe Schwarcz is well known for his informative and entertaining public lectures on topics ranging from the chemistry of love to the science of aging. Professor Schwarcz has received numerous awards for teaching chemistry and for interpreting science for the public and is the only non-American ever to win the American Chemical Society's prestigious Grady-Stack Award for demystifying chemistry. He hosts "The Dr. Joe Show" on Montreal's CJAD and has appeared hundreds of times on The Discovery Channel, CTV, CBC, TV Ontario and Global Television. Dr. Schwarcz writes a regular newspaper column entitled "The Right Chemistry" and has authored 11 best-selling books. In November, 2011 the McGill Office for Science and Society received the largest gift ever in Canadian history (\$5.5 million) from philanthropist Lorne Trottier to further its work in promoting scientific education and critical thinking.*



**T**he McGill Office for Science and Society (OSS) was established in 1998 with a mandate of interpreting science for the public, fostering critical thinking and separating sense from nonsense. At that time the "information age" was already well upon us, with the media spewing daily reports about the hottest scientific studies. Virtually every day seemed to dawn with some "breakthrough" research that either warned us about something that would hasten our demise, or comforted us with the prospects of some miraculous novel drug or dietary supplement. Established scientists as well as uneducated laymen then weighed in on these issues with their opinions.

Allegations about research tainted by vested interests were met with accusations of irrational fear-mongering, often leaving the public bewildered. Adding to the confusion was the incredible amount of information instantly available with a few computer key strokes. Clearly, the Internet was a wonderful source of reliable information if one knew where to look, but it was also evident that websites promoting nonsensical views or products were often more seductive than those based on rational science. Charlatans and assorted kooks were successfully trapping people in a web of deceit. Our hope was that the McGill Office for Science and Society would contribute towards untangling that web and serve as a voice of reason, separating myth from fact, hype from hope.

*... continues on page 46*

... continued from page 45



"It is a capital mistake to theorize before one has data. Insensibly one begins to twist facts to suit theories, instead of theories to suit facts." — Sir Arthur Conan Doyle

Over the last decade my colleagues Ariel Fenster, David Harpp and I have tried to champion the cause of decision-making based on proper scientific research rather than on hearsay or emotion. We do this via public lectures, our website, presentations to elementary and high school students, radio and television programs, newspaper columns, invited appearances in front of parliamentary committees and responses to phone calls and emails. On occasion we have even investigated some consumer products ourselves and have visited various "healers" and psychics incognito, getting a first hand look at what fraud is all about. Our student associates have been an integral part of this effort, going on after their stint in the Office to pursue careers in medicine or science, "spreading the word."

Whether or not an artificial sweetener, a drug, a cleaning agent, a plastic component or a cosmetic is successful in the market place is of no interest to us, but its efficacy and safety profile certainly is. Are the claims of efficacy backed up by proper peer-reviewed research? Have safety issues been adequately addressed? Is the advertising truthful? Are attempts to remove a product from the market based on sound science? We accept no funding from any vested interest, and therefore our only allegiance is to the scientific method.

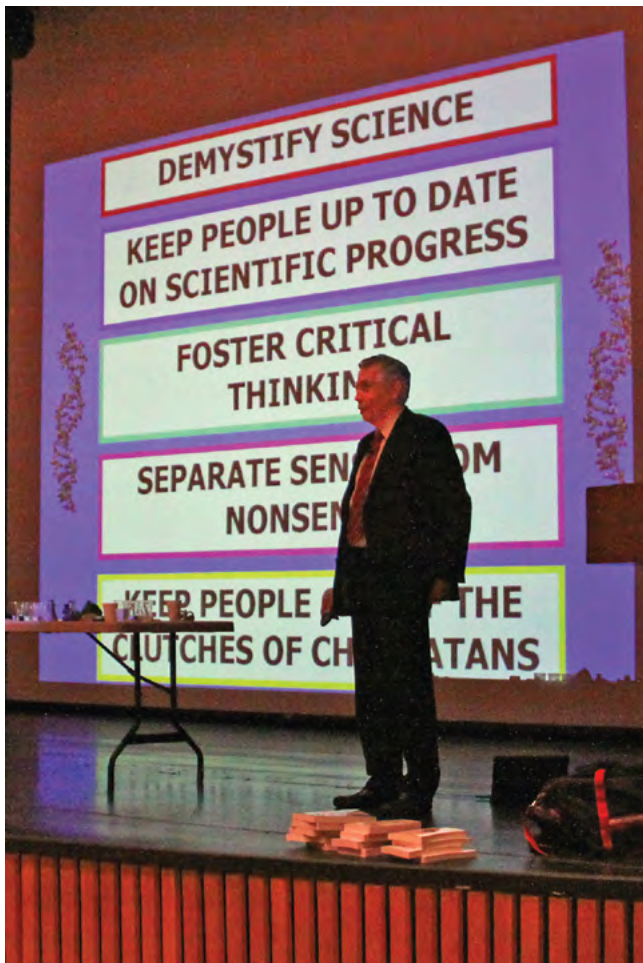
As one might expect, we have to deal with a broad scope of issues and are called upon to answer a large variety of questions. Of course there are some common recurrent ones with relatively easy answers. Is it true that plastic water bottles left in a hot car leach cancer-causing chemicals into the water? No! Can tiny amounts of lead in the blood really affect the IQ of children? Yes! Most questions that come our way, though, do not have a clear yes or no answer. Queries about phthalates in toys, genetically modified foods, herbal remedies, cell phones, Teflon, fluoride, dental fillings, pesticides, vitamins or cosmetic ingredients fall into that category. Our task here is to offer an opinion based on the most reliable current information. It certainly is possible that such an opinion may change as more facts come to light. After all, science is an ongoing and self-correcting discipline.

There are also amusing questions galore. Like the one from a lady who asked if what her "Health Naturalist" told her was correct. I think I could have made a pretty good guess at that one even before hearing the question. Apparently this sage opined that the earth and all things in it rotate clockwise and that cooking food in a microwave oven alters this natural rotation and makes chromosomes in the food rotate counter-clockwise, destroying the food's nutritional value. That just may be the most ludicrous claim I ever heard, although the competition in this area is very stiff. Witness the suggestion by another caller who claimed that taking clozapine had affected her aura which had been long and wide but was now withering.

Some questions do raise interesting points. A lady visiting her sister in the Caribbean found that while her sister's bed was overrun with ants, hers was free of the creatures. Could it have anything to do with the fact that her sister was a diabetic? Possibly. At one time physicians used to diagnose diabetes by tasting a patient's urine to see if it was sweet. And ants are known to go for sweets. Ditto fruit flies. A gentleman queried whether wine

in which some fruit flies had drowned was safe to drink. It is. But the question gave us an idea for fruit fly control. Just leave a few glasses of wine around and wait till the flies drink themselves to death. It works!

Finally, there are questions we just can't answer. Where does one go to get a goldfish autopsied if there is a suspicion it has been poisoned? What is the best way to remove the green color from an emu egg before dying it? Does favoring the "flat" or the "drum" of a chicken wing reveal anything about the diner's personality? Can a gentleman's lack of success on his honeymoon night have anything to do with having just consumed twelve bananas? I didn't dare ask about the motivation for the banana frenzy.



... continues on page 48

## Queen's Education Letter

Queen's *Education Letter* is a thematic bi-annual publication of the Queen's Faculty of Education. © 2013 Queen's University, Faculty of Education. Special permission is required to reproduce in any manner, in whole or in part, the material contained herein.

### Guest Editor

**Lynda E.C. Colgan, Ph.D.**

Queen's Faculty of Education

### Senior Editor

**Rosa Bruno-Jofré, Ph.D.**

Queen's Faculty of Education

### Managing Editor

**Vicky Arnold**

Queen's Faculty of Education

### Subscription

Print copies will be delivered to select locations free of charge. If you would like to receive print copies, please contact **Vicky Arnold** (613-533-6000 ext 74305, [vicky.arnold@queensu.ca](mailto:vicky.arnold@queensu.ca)). Queen's Education Letter is also available online at [www.educ.queensu.ca/community/educationletter.html](http://www.educ.queensu.ca/community/educationletter.html).

The Queen's Education Letter is supported by annually-pledged donations from alumni and friends as well as matching funds from the Office of the Dean of Education.

ISBN # 978155339157-9



FACULTY OF EDUCATION  
Duncan McArthur Hall  
Queen's University  
511 Union St.  
Kingston, Ontario Canada  
K7M 5R7  
[educ.queensu.ca](http://educ.queensu.ca)

... continued from page 47

## Resources for Teachers and Parents

[www.educ.queensu.ca/community/outreachcentre/resources](http://www.educ.queensu.ca/community/outreachcentre/resources)

*Aboriginal Access to Engineering*. Kingston, ON: Faculty of Engineering and Applied Science, Queen's University. [www.aboriginalaccess.ca](http://www.aboriginalaccess.ca)

Anderson, Sally. *How Many Ways Can You Make Five? A Parent's Guide to Exploring Math with Children's Books*. Lewisville, NC: Gryphon Books, 2012.

Chapple, Nancy and Judi Waters. Project Leaders. *Esso Family Math Resources*. London, ON: Faculty of Education, Western University, [2013]. [www.edu.uwo.ca/essofamilymath/resource.asp](http://www.edu.uwo.ca/essofamilymath/resource.asp)

Colgan, L.E.C., and Kurisu, Jane. *Mathemagic: Number Tricks*. Toronto, ON: Kids Can Press, 2011.

Dadila-Coates, Grace. *Family Math II: Achieving Success in Mathematics*. Berkeley, CA: Lawrence Hall of Science, 2003.

Fenichel, Marilyn, Schweingruber, Heidi A. "Biographical Sketches of Authors." *Surrounded by Science: Learning Science in Informal Environments*. Washington, DC: The National Academies Press, 2010.

Merrill, Chris and Jenny Daugherty. "STEM Education and Leadership: A Mathematics and Science Partnership Approach." *Journal of Technology Education* 21(2): [scholar.lib.vt.edu/ejournals/JTE/v21n2/merrill](http://scholar.lib.vt.edu/ejournals/JTE/v21n2/merrill)

Moyer, Richard H. and Susan A. Everett. *Putting the E in STEM Teaching and Learning*. Arlington, VA: National Science Teachers Association, 2012. Preview available: [books.google.ca/books?id=y5FINRs7x-sC&lpg=PP1&pg=PR7#v=onepage&q&f=false](http://books.google.ca/books?id=y5FINRs7x-sC&lpg=PP1&pg=PR7#v=onepage&q&f=false)

National Middle School Association. Research Summary: Parent Involvement. Westerville, OH: 2006. [www.amle.org/Research/ResearchSummaries/ParentInvolvement/tabid/274/Default.aspx](http://www.amle.org/Research/ResearchSummaries/ParentInvolvement/tabid/274/Default.aspx)

*Natural Curiosity: A Resource for Teachers*. Toronto, ON: The Laboratory School at the Dr. Eric Jackman Institute of Child Study, c2011. [www.naturalcuriosity.ca](http://www.naturalcuriosity.ca)

Schwarcz, Joseph A. *Dr. Joe's Brain Sparks: 179 Inspiring and Enlightening Inquiries into the Science of Everyday Life*. Toronto, ON: Doubleday, 2010.

Science NetLinks: *Afterschool Resources*. Washington, DC: American Association for the Advancement of Science. [sciencenetlinks.com/afterschool-resources](http://sciencenetlinks.com/afterschool-resources)

Stenmark Jean, Thompson Virginia and Cossey, Ruth. *Family Math*. Berkeley, CA: The Lawrence Hall of Science, 1986.

*Useful [Science] Sites*. Dresden, ON: Science Teacher's Association of Ontario (STAO), [2013]. [stao.ca/res2/links.php](http://stao.ca/res2/links.php)