Premier’s Teachers Mutual Bank New and Emerging Technologies Scholarship

Sydney STEAM

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STEAM – integrating the arts with science, technology, engineering and maths reflects a natural intersection of subject areas. STEAM teachers are true collaborators, and to really engage with the skills needed to grow our 21st century learners – collaboration, creativity, critical thinking and communication – teachers need to develop those skills themselves. The Teachers Mutual Bank fully supports the growth of such skills and it is with much gratitude that I thank Teachers Mutual Bank and the Premier’s Teachers Scholarship program for enabling me to travel to the United States at the end of 2015 and start of 2016 to further explore my interest in STEAM education.

Aim

My primary goal is to embed the arts into STEM-based education – education that integrates science, technology, engineering and maths – to reinvigorate the concept of learning by doing. The main focus of my study tour was to continue learning and sharing resources and ideas associated with targeted STEAM teaching and learning environments. My aim was to strengthen current developments in parallel curriculum possibilities located in the STEM to STEAM environment. In particular, my primary intention was to enhance a range of peer-to-peer professional development opportunities to augment my role of STEAM innovator at an independent school in Sydney.

Significant Learnings

My study tour will read a little like a travelogue of STEAM adventure. Each city provided its own significant learnings, which collectively provided a comprehensive taste of US STEAM initiatives.

*New York City & Long Island*

My first meeting on my tour was with Glen Whitney and Cindy Lawrence at MoMath, the National Museum of Mathematics in Manhattan.[[1]](#endnote-1) We discussed the logistics of the collaborative workshop I was to present the next day at Brookhaven National Laboratory in Long Island.

Before travelling north with the directors, I attended the MoMath Family Friday presentation on the subject of tensegrity, a structural principle made famous by architect Buckminster Fuller and more recently, by sculptor Kenneth Snelson. There were lots of kids, parents and grandparents, all having a go at making 3D representations of a range of polytetrahedrons.

* + **Brookhaven National Laboratory**

Brookhaven National Laboratory is a national scientific facility where the government built a relativistic heavy ion collider before CERN. MoMath have a partnership with a gifted and talented mathematics class there which runs one Saturday per month. The collaborative project presented that day was related to the mathematics of mazes and labyrinths. It resulted in the kids (years 6–8) making a maze puzzle according to their individually constructed 2D mazes. Glen delivered his own lecture that day to the older group. His topic was related to working out the lowest common multiples of polynomials.

* + **MoMath**

The MoMath presentations I planned to deliver were scheduled over the next two days at the museum and also at a Brooklyn elementary school called the PAVE Academy.[[2]](#endnote-2) PAVE schools provide pre-Kindergarten to Year 8 students with a rigorous academic program that prepares students for higher education**.** My experience at the school resulted in significant feedback for MoMath and self-reflection for me in differentiating the content of STEAM activities. Our session was aligned with PAVE’s core values of perseverance, achievement, vibrance and excellent character.

In a professional development session at MoMath later that day, participants ranged in teaching disciplines from STEM subjects to facilitators for library makerspaces (areas where people gather to make and create). They were challenged with the task of completing two mathematical lamp structures, plus quizzed on the aspects of experiential STEM learning in the context of before, during and after making.

* + **The Harmonics Series**

I joined my MoMath colleagues for the first in their Harmonics Series,[[3]](#endnote-3) featuring performances by mathematician and pianist Noam Elkies and pianist Orli Shaham. These two were joined in conversation with NYC public radio’s Piano Puzzler, Bruce Adolphe. This was the first concert in the series. The theme was All Things Equal: Music and Math at the Piano. Noam was the youngest Harvard professor ever appointed and both he and Orli were once students of Bruce Adolphe’s when he was teaching at the Juilliard School. The concert was held in the Engelman Recital Hall, in the Baruch Performing Arts Center. ‘Baruch Performing Arts Center convenes a conversation across the disciplines of art, science, and the humanities, as well as across the panoply of world societies that are represented in Baruch’s diverse student body.’[[4]](#endnote-4)

* + **East Side Middle School**

I visited East Side Middle School to enjoy an afternoon of paper engineering with a talented middle school teacher, Anita Yu. We exchanged ideas and resources about STEAM projects, especially those with a mathematical focus. Ms Yu put me in touch with Liz Clark-Garvey from Math for America (MFA) and Professor George Hart. Ms Yu was lucky enough to have Professor George Hart[[5]](#endnote-5) visit her Math/Art class. He is the master of geometric sculpture and an ongoing contributor to MoMath events and activities. His daughter Vi Hart[[6]](#endnote-6) is also a regular contributor to MoMath Family Friday programs and holiday math camps. Vi describes herself as a ‘recreational mathemusician’.

* + **Smithsonian Cooper Hewitt Design Museum**

I met with Caroline Payson, Cooper-Hewitt’s Director of Education.[[7]](#endnote-7) She introduced me to Michelle Cheng, the Professional Development Manager at Cooper Hewitt and most appropriate STEAM contact for the Museum. They were all busy trying to complete tasks before the holidays and I was most grateful for the time they gave me to discuss their work and the success of their outreach programs.

The design museum’s education focus is on global design incentives and project-based learning. After our meeting, I spent some time on the museum floor. Visitors are issued with special cyber pens to interact and record the artefacts of most individual interest. The cyber pens were developed by Seb Chan, recognised as Australia’s international museums sector digital revolutionary.

* + **Intrepid Sea, Air and Space Museum**

My visit to the Intrepid Sea, Air and Space Museum allowed me to learn a lot about the NASA space shuttle projects as they evolved over the years, with the main attraction being the Enterprise (SS1) on view in the museum. A variety of information delivery and questioning was used within the Enterprise learning journey, including virtual reality, responsive codes and augmented reality. This is a great example of game based e-learning in a museum–education context and easily transferable to the classroom or school setting.

* + **Santiago Calatrava’s Oculus**

There is much STEAM content to be found around the reconstructed World Trade Centre zone. Even the names surrounding the Pools of Reflection at the Ground Zero site were designed to be evenly spaced via computational programming. All things being equal, Santiago Calatrava’s Oculus above the World Trade Centre’s new PATH subway station is a biomimetic visual treat, an architectural beauty and an engineering wonder as its ribs span out between extreme verticality of the surrounds.

* + **LittleBits**

LittleBits[[8]](#endnote-8) are easy-to-use magnetic electronic circuitry blocks. Liza Stark, Community and Content Lead Officer, showed me around the LittleBits headquarters before we sat down and swapped STEAM stories and resources. The premises display the history of LittleBits on the walls of the entry vestibule, from concept to current times, including the early cardboard prototypes of how the units might look.

Ayah Bdeir worked on this project when she was at MIT. It is now one of the most successful tech startups powered by Kickstarter (where much of the venture capital was sourced). The LittleBits company is housed in an iconic 1931 building recognised for its innovation at the time. It is now full of startups. The corridors are long and shiny, like inside an imagined mainframe. People get around on scooters like at Google. Extremely on-trend.

* + **MAD**

The Museum of Art and Design - MAD Museum[[9]](#endnote-9) ‘…explores the value of ‘making’ across all fields of contemporary creative practice. MAD focuses on ‘the ways in which artists and designers transform the world around us, through processes ranging from the artisanal to the digital’.

The Artist Studios at MAD host artists and designers daily as they produce their work in a live studio environment. Visitors are able to meet working artists and ask questions about their practice. The artists openly discuss their processes, materials, and concepts and provide a wonderful opportunity to interact.

* + **MoMath and the winter solstice**

I volunteered at the MoMath Winter Solstice Star event on 22 December outside the Flatiron building because the MoMath CEO said they could do with more people wrangling. The event was taking place ‘Since the angle of the points of a heptagram is within a tenth of a degree of the highest point the sun achieved over New York City on the solstice, MoMath thought that bringing hundreds of people together to create a glowing heptagram would be a great way to observe the solstice.’ It was great fun to be a part of this quirky event. I assisted MoMath staff with chalking the shape of the heptagram into the sidewalk so that people could form the star shape along the lines of intersection without difficulty. This amounted to being one of the best experiences of my study tour.

* + **Eyebeam**

My visit to the South Street Seaport District was to interact with the collaborative art and activism work by Eyebeam.[[10]](#endnote-10) This is a redeveloped district in one of the oldest parts of New York. Many community collaborations are going on there, plus the usual amount of artisanal fare and retail. EyeBeam is an art and technology organisation that runs many programs related to creative research. Eyebeam is a partner with the South Street Seaport’s Culture District, providing hands-on space for anyone curious about technology and fashion to new works by emerging artists which inquire into the relationship between geographic space and history in a post-digital world.

*Philadelphia*

* + **Work on What you Love…**

Bruce Mau is a visionary designer, champion of innovation and change-maker when it comes to global challenges. Mau was responsible for the term ‘wicked’ in design. That is, a wicked problem to be solved. So I was very happy to see that the Philadelphia Museum of Art was showing a Bruce Mau exhibition, Work on What You Love, while I was visiting. His work with architects, artists, scientists and technologists is at the heart of contemporary design practice. The [Philadelphia Museum of Art](https://www.philamuseum.org/exhibitions/830.html) has a comprehensive site related to the Mau exhibition that does more justice than any analysis from me.

* + **Temple and Rhyme**

In Philadelphia I met with Dr Wendy Magee, Associate Professor of Music Therapy at Temple University. Dr Magee had attended one of my earlier STEAM workshops at MoMath and we got to talking about the possibility of future collaboration. We spent a couple of days mulling over ideas related to STEAM projects and how her musical expertise might fit in an education context external to or in collaboration with Temple. Dr Magee introduced me to her work with the Norwegian Academy of Music and more specifically with Rhyme, a five-year research project (2010–2015) financed by the Research Council of Norway through the VERDIKT program. ‘The goal of the RHYME project is to improve health and life quality for persons with severe disabilities, through use of “co-creative tangibles” ’.[[11]](#endnote-11)

*Providence, Rhode Island*

* + **RISD Works and the Nature Lab**

Rhode Island School of Design (RISD)[[12]](#endnote-12) is the home of STEM to STEAM. I met with Lucia Monge, Operations Assistant at the RISD Nature Lab, and Neal Overstrom, RISD Director. His work is mainly project-based learning experiences, focused on promoting environmental education and literacy. At RISD, Neale is responsible for encouraging the exploration of living systems and how they intersect with technology and aesthetics, as well as promoting designing for sustainability. We spoke a lot about how design for the built environment can be influenced by biological influences, particularly the ways in which pattern, form and living elements may reinforce the human–nature connection. We also spoke about funding STEM to STEAM initiatives and future collaboration opportunities. I was extremely privileged to spend such a wonderful afternoon with Neale and Lucia. I am very grateful that they responded to my reaching out all those months ago when I was planning for this study tour.

Before attending RISD Lucia was teaching science K–6 in her home town, Lima, Peru. She was completing her Masters at RISD at that time when John Maeda was the RISD president, so there was a lot of talk about RISD’s involvement in STEAM. The school is still working on how STEAM is integrated through curriculum, and now there is a STEAM representative, Babette Alina, in the academic body.

* + **Nature Lab – RISD**

The Nature Lab was started in 1937 by Edna Lawrence, a Foundation Studies teacher at RISD. She would bring specimens back from her travels so that the students could draw from them an understanding of structure of forms and patterns found in nature. Now the collection has nearly 80,000 specimens that are categorised in different areas such as natural history, microscopy and sound water biology.

Brown University has a close relationship with RISD. The two institutions share a passion for the connection between art, design and science. The RISD Co-Works is the collective makerspace available for students from both colleges to use. Students enrolled in courses outside of industrial design areas have access to digital fabrication methods to explore their hybrid art/science concepts. RISD Co-Works contains resources common to most makerspaces: laser cutting, 3D modelling and printing, CNC machining, additive technologies and big areas for developing ideas and prototyping solutions.

*Chicago*

* + **The School of the Art Institute**

Before coming on the tour, I made contact with Linda Keane, Professor of Architecture, School of the Art Institute, Chicago (SAIC). Linda wears many hats, one of which is the co-founder of NEXT.cc,[[13]](#endnote-13) a creative commons online repository for STEAM education resources. Linda invited me to collaborate with her in a folding architecture workshop to be held at SAIC with students from the Global Citizenship Experience, Chicago Lab School.[[14]](#endnote-14) Our paper engineering workshop was based on pre-workshop activities from NEXT.cc and paper resources from Lumifold, the project I developed to deliver to MoMath in NYC. The students ranged in ages from 15 to 18, accompanied by one teacher and a technical assistant. The Lab school kids were very well versed in cross-curricular integrated learning. Some of the feedback we received is here:

* + ‘The most interesting portion of the lecture was about biomimicry. I had a general idea of what biomimicry was prior to the commencement of the lecture but the words of an educated individual in the field as well as images and physical objects allowed me to gain a much more comprehensive understanding...’
	+ ‘The most valuable takeaway I had from the day came as we were departing. The professor explained how we had just turned the ordinary into the extraordinary. This idea of transforming ordinary into extraordinary allows me to look at objects as well as nature in a whole new perspective.’

*San Francisco & San Diego*

* + **Autodesk**

It is easy to spend a lot of time in the Autodesk gallery[[15]](#endnote-15) in San Francisco. This is such a comprehensive exposition of the range of digital technologies developed by that group and many examples of its applications. As digital educators, many of us use the Autodesk design software range so it was wonderful to make the connection between classroom activities and the wealth of major designs and developments using almost exactly the same technology to achieve successful design solutions.

* + **Adventurous Thinking**

I met with Sally Dominguez, an Australian leading the way in Adventurous Thinking,[[16]](#endnote-16) the course she developed and delivers at Stanford University. We had a long discussion about the possibilities of interdisciplinary project opportunities in STEAM education in schools and tertiary settings. Sally has extensive experience in design thinking strategies and innovative project delivery.

* + **The Exploratorium**

It’s easy to stay for an entire day at the Exploratorium,[[17]](#endnote-17) a museum dedicated to the exploration of science, art and human perception located on the famous San Francisco Embarcadero waterfront center. I was inside the museum until my legs ached and cerebral saturation set in. In fact, every exhibit in this museum is totally riveting. There is so much to learn at all levels and so much to interact with to help the learning. It is very impressive, especially mathematics section, where I was particularly captivated with interactive exhibits devoted to the parabola and hyperbola.

* + **High Tech High**

There is much information available online related to the mission of San Diego’s High Tech High (HTH),[[18]](#endnote-18) but a visit allowed me to see their pedagogy in operation. The HTH model of equality is inspiring and much more ethical than any I’ve seen in a first world education environment. HTH personnel shared their program project planning and tuning documents with me. These contain excellent development, implementation and evaluation resources for project-based learning.

HTH also considers the exhibition of student work to be an important aspect of project culmination and dissemination. Every corridor is full of wonderful examples of cross-curricular STEAM-based learning coupled with gracious like-minded teachers ready to elaborate on the Positive Behaviour for Learning context. I visited a range of middle school classes and I was most impressed with the way that the students worked with seemingly disparate learning criteria to create a tactile exhibition piece that made sense to a visiting audience.

Outcome

Collaborations and opportunities arising as a result of my study tour have been significant. These include:

* + MoMath directors visited Australia to investigate the possibilities of a mathematics museum being developed locally.
	+ Global collaboration between littleBits and the International Grammar School is currently underway in the form of inclusion in the Chapter School program, launched in May.
	+ littleBits has been implemented into the International Grammar School curriculum planning in Years 1, 4 and 8.
	+ Lumifold workshops were presented in Brisbane at the Asia Pacific Architecture Festival in March and in Vivid Ideas, Sydney, in May and June.
	+ There has been STEAM collaboration between International Grammar School and Queenwood School using paper engineering and ideas related to tensegrity.
	+ I have had ongoing dialogue with Ms Yu from East Side Middle School in New York, including plans for future global collaborations.
	+ Linda Keane from NEXT.cc and I collaborated on the delivery of a presentation related to biomimicry and paper engineering for OZeLive16 - an online educator’s forum for sharing education technology strategies.
	+ I will present a range of papers on STEAM education at the Bridges Art Maths Conference in Finland in August.

Conclusion

STEAM teachers are collaborators. Development of learning opportunities that integrate STEM content with Arts content requires input from more than one educator. The success of STEAM programming is reliant on the motivation and willingness of teachers and other personnel within discreet subject areas, those who possess specific skills, to join together in order to provide balanced content in a project. In relation to STEAM, contributors may be found in the areas of Science, Maths, TAS, and the Arts, including Humanities and Language Arts. Additionally, a STEAM project may draw on the expertise of external stakeholders such as museum educators, tech startup entrepreneurs, tertiary educators and pre-service teachers, with support from maintenance and facilities teams in schools. STEAM, as current educational imperitive, can only be successful with encouragement from school leadership. The range of partnerships and collaborative initiatives that are supported by research study tours such as mine serve to enhance the collaboration, creativity, critical thinking and communication skills we all need as educators and learners:. The current National STEM School Education Strategy[[19]](#endnote-19) mandates a renewed focus on STEM to ensure ‘that all young Australians are equipped with the necessary STEM skills and knowledge that they will need to succeed.’ To manage this, both STEM and STEAM teachers must interact with museums, academics, entrepreneurs and creatives in their communities and beyond to provide a full STEAM experience for themselves and their students.

1. [http//momath.org/](http/momath.org/) [↑](#endnote-ref-1)
2. <http://paveacademy.org/> [↑](#endnote-ref-2)
3. <http://momath.org/home/harmonic-series/> [↑](#endnote-ref-3)
4. <http://www.baruch.cuny.edu/bpac/> [↑](#endnote-ref-4)
5. <http://www.georgehart.com/index.html> [↑](#endnote-ref-5)
6. <https://vimeo.com/vihart> [↑](#endnote-ref-6)
7. <http://www.cooperhewitt.org/> [↑](#endnote-ref-7)
8. <http://littlebits.cc/> [↑](#endnote-ref-8)
9. <http://www.madmuseum.org/> [↑](#endnote-ref-9)
10. <http://eyebeam.org/> [↑](#endnote-ref-10)
11. <http://nmh.no/en/research/centre_for_music_and_health/projects/rhyme-1> [↑](#endnote-ref-11)
12. <http://www.risd.edu/> [↑](#endnote-ref-12)
13. <http://www.next.cc/> [↑](#endnote-ref-13)
14. <https://gcelabschool.com/> [↑](#endnote-ref-14)
15. <http://www.autodesk.com/gallery/overview> [↑](#endnote-ref-15)
16. <http://www.adventurousthinking.com/sally-dominguez.html> [↑](#endnote-ref-16)
17. <http://www.exploratorium.edu/> [↑](#endnote-ref-17)
18. <http://www.hightechhigh.org/> [↑](#endnote-ref-18)
19. Education Council, National STEM school education strategy, 2016 – 2026. [↑](#endnote-ref-19)