

Enhancing urban teachers' STEM and leadership capacities: A preliminary report on a unique private-public-public partnership by Punya Mishra, Leigh Graves-Wolf, Christopher Seals, Rohit Mehta & Inese Berzina-Pitcher

epiSTEME 6

Focus Theme

Emerging Computational Media and Science Education

15-18 December, 2015

Homi Bhabha Centre for Science and Education

TIFR, Mumbai

PROCEEDINGS

Editors

Sanjay Chandrasekharan

Sahana Murthy

Gargi Banerjee

Adithi Muralidhar

2015

Homi Bhabha Centre for Science Education

Tata Institute of Fundamental Research

Mumbai, India

Copyright Notice

© Homi Bhabha Centre for Science Education, TIFR, Mumbai, India, 2015

The Homi Bhabha Centre for Science Education, TIFR, applies the Creative Commons Attribution-ShareAlike 3.0 Unported License (CC-BY SA 3.0) to this book and the articles published in this book. Read the humanreadable summary (http://creativecommons.org/licenses/by-sa/3.0/deed.en_US) or the full license legal code (<http://creativecommons.org/licenses/by-sa/3.0/legalcode>) of the applied license.

Under this license, authors retain ownership of the copyright for their content, but allow anyone to download, reuse, reprint, modify, distribute, and/or copy the content **as long as the original authors and source are cited. No permission is required from the authors or the publishers.**

Authors are able to waive the terms of the CC license and enter into separate, additional contractual arrangements for the non-exclusive distribution and subsequent publication of this work (e.g., publish a revised version in a journal, post it to an institutional repository or publish it in a book), **with an acknowledgement of its initial presentation at this conference.**

In addition, authors are encouraged to post and share their work online (e.g., in institutional repositories or on their website).

First published in India in 2015 by CinnamonTeal Publishing

ISBN 978-93-85523-48-9



CinnamonTeal Publishing,
Plot No 16, Housing Board Colony
Gogol, Margao
Goa 403601 India
www.cinnamontea.in

On behalf of:
Homi Bhabha Centre for Science Education
Tata Institute of Fundamental Research
V. N. Purav Marg, Mankhurd, Mumbai, 400088

ENHANCING URBAN TEACHERS STEM AND LEADERSHIP CAPACITIES: A PRELIMINARY REPORT ON A UNIQUE PRIVATE-PUBLIC-PUBLIC PARTNERSHIP

Punya Mishra, Leigh Graves-Wolf, Christopher Seals,
Rohit Mehta & Inese Berzina-Pitcher

Michigan State University (USA)

punya@msu.edu, gravele@msu.edu, sealschr@msu.edu, mehtaro3@msu.edu,
berzina1@msu.edu

This paper discusses an example of a partnership to enhance the STEM (Science, Technology, Engineering & Mathematics) teaching and leadership capacities of teachers in a large urban school district in the United States. Incorporating educational innovation and instituting systemic change in public school systems is a complex endeavor (Blumenfeld, Fishman, Krajcik, Marx & Soloway, 2000). We describe our instructional approach, using the power of experience (Dewey, 1938) involving real world, hands-on engagement with tools and pedagogies. Our fellowship program is driven by our research on the Technology Pedagogical Content Knowledge (TPACK) framework (Mishra & Koehler, 2006), which guides us in discussion of our instructional practices, and our findings on teacher efficacy and leadership of our fellows.

INTRODUCTION

Incorporating educational innovation and instituting systemic change in public school systems is a complex endeavor (Blumenfeld et al. 2000; Guskey, 1990), requiring not just instructional change and teacher professional development but rather a systematic involvement of a range of stakeholders so that the innovation can be sustained over a period of time. In this paper we describe an example of a teacher education program that was formed through a unique private-public-public partnership that seeks to develop the STEM and leadership skills of 125 teachers in the Chicago Public Schools over three years. Especially of interest is the manner use of blended and hybrid technologies and approaches to engage teachers in the project on a year-around basis.

This paper serves as a first report on a work in progress, focusing on the first year of a three-year project. Within the broader context of the project, we will focus on the instructional strategies used to develop teachers' capacity in STEM education and leadership. Integrating technology into the academic environment requires skills and creativity from the teachers' technological pedagogical content knowledge (TPACK) (Mishra & Koehler, 2006). However, building a teachers' TPACK requires specific training since most technologies are not designed for classroom and academic settings (Koehler & Mishra, 2008). The MSU UrbanSTEM & Leadership program uses the power of experience (Dewey, 1938) to develop the capacity of classroom teachers in STEM disciplines to design transformative and innovative, multimodal instructional experiences and active learning communities of practice – all as means of enhancing the quality of instruction in their own classrooms. The MSU UrbanSTEM and leadership program launched with an intensive face-to-face, two week, summer cohort session in 2014. Twenty-five STEM teachers in Chicago applied what they learned from the summer session to their classroom teaching experiences and to their interactions with other teachers in their schools.

This paper addresses the overall design of the program, and is divided into the following overarching sections: (a) view of project from stakeholder perspectives, (b) curriculum and practices, and (c) program evaluation including changes in teacher competence, teacher leadership, and teacher ability to integrate technology into their pedagogy.

PROJECT FROM VARIOUS PERSPECTIVES

Overall Partnership & Project

This program was the result of ongoing discussion and relationship building between a global IT company and Michigan State University. The IT Company has a strong history of commitment to education (primarily in India) and was seeking to expand its work into the US (since it now has a large presence in the country). Michigan State with its land-grant tradition and commitment to both public schools and urban education was a good fit for this partnership. Chicago Public Schools, the third-leg of this partnership (the third largest urban school district in the nation) emerged as a key partner in this process—given MSU’s ongoing relationship with them. Microsoft emerged towards the end as an important partner as well. Through a series of interactions we saw that our interests and values were aligned, while we each brought separate strengths to the table.

Chicago Public School Partnership and Perspective

Chicago Public Schools (CPS) is the third largest school district in the nation with 664 schools serving 394,000 students. To support the district’s 22,500 teachers, Chicago Public Schools engages partners with proven success records to provide professional development aimed at increasing the student achievement for all learners. An exemplary model of such collaboration is the Michigan State University (MSU) Urban STEM program in which CPS and MSU work together to identify, recruit, and support STEM teachers in this one-year graduate certificate program grounded in the context of a large urban district.

Similar to many large urban districts, Chicago Public Schools is presented with numerous challenges in the pursuit to offer all students with high-quality opportunities to engage in learning. The lowest performing schools in the U.S. are often in Urban metropolitan areas (Tajalli & Ophiem, 2004). This disparity exists because of external challenges such as poverty, transience, and socio-political forces. Other challenges exist within the four walls of a school including punitive behavior management, poor teacher preparation, and underfunded teacher training and induction. Ultimately, these factors combine into a heavy weight bearing down on our most under-represented student’s shoulders, preventing them from learning, opportunity, and success beyond K-12 education. This is especially true when engaging students in STEM related instruction where cultural, racial, economic, and gender divides are ever present.

Goldhaber (2002) concluded that what teachers learn in their education and course work adds to their teaching and classroom capabilities. The MSU Urban STEM Fellowship takes Goldhaber’s perspective and responds to these challenges by working with CPS to identify successful teachers working in under-served schools to improve their instruction thus breaking down barriers, especially with minority girls, and allowing students equal opportunity to explore STEM content in a safe, hands on, learning environment. There are unique challenges and strategies required to meet these challenges for the development of a genuine program.

Instructional Framework

For the past 15 years, the Michigan State University Master of Arts in Educational Technology (MAET) program has been offering a hybrid summer graduate school experience specifically targeted towards K-12 practitioners. This structure for the 9-credit summer program consists of two weeks of intense face-to-face instruction followed by 3 weeks of online instruction. This innovative (Terry et al., 2013) and award winning (Mishra et al., 2012) model gave us the basis for creating a structure for the MSU UrbanSTEM fellowship program. We had the unique opportunity with the MSU UrbanSTEM fellows to iterate on this idea and stretch a 9 credit graduate certificate into a year-long hybrid experience. Face-to-face time is crucial for developing a sense of community and camaraderie (Wolf, 2011). We continued with the 2-week face-to-face summer model and embedded 4 face-to-face meetings and online meetings throughout the following school year.

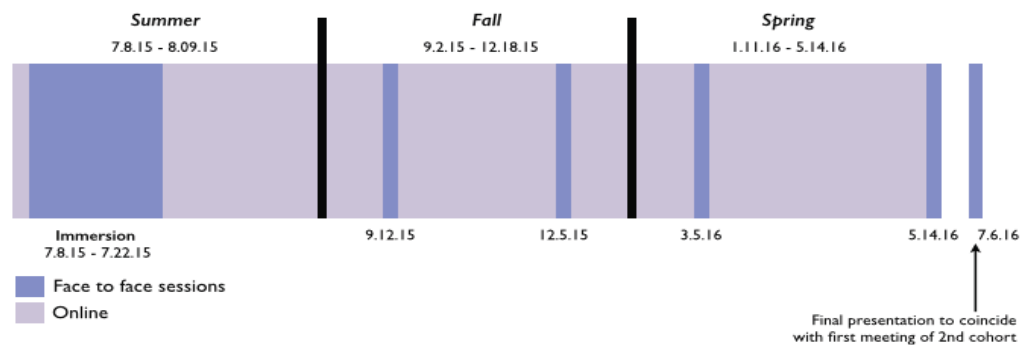


Figure 1: A typical calendar year of the MSUrbanSTEM project

CURRICULUM & PRACTICES

Face-to-Face Summer Session: Wisdom Begins in Wonder

During the eleven-day face-to-face summer session, the teaching team laid the crucial foundation for building a sustainable learning community. Our key goals were to provide a transformative shift in the fellows by providing new ways to interpret ideas, technology, pedagogy, and new ways of thinking. The basic structure of each day was formulated to disrupt what the fellows had come to know as *adult learning or teacher professional development*. Assignments such as the iImage, Explain it to Me video, teaching demonstrations and others were intertwined with Quickfire Challenges (Wolf, 2009), discussions, and hands-on activities. This face-to-face time allowed us to build a strong foundation for future learning. The assignments included: presentations by the fellows of their best lesson plans, creation of short problem-based learning videos, engaging in workshops on the role of improvisation in teaching, visits to science museums, development of a project to be implemented through the fall and spring semesters, and a range of other micro, and macro design activities. Additionally, the fellows (25 teachers) participated in the fellowship by engaging with the projects they have completed, including the book that they published entitled, *The Roots of STEM: A collection of lesson plans for teachers by teachers*, Michigan State University, 2014.

Fall semester: Designing (& re-designing) Practice

Throughout the fall semester, the fellows continued to explore the key program themes, but also began to focus on application-oriented activities. There were various assignments, activities, and instructional support that facilitated the fellows' initial implementation of the program themes. The major project assignment that the fellows work on throughout the year is their DreamIT project, which also commenced in fall. Fellows shared their projects with various stakeholders in the form of teaching demonstrations (Swenson & Mitchell, 2006), where they collected, reflected, and acted on feedback related to their projects. Fellows were also asked to identify a STEM related book that addressed their content from a unique perspective. Through a deep reading, review, and author interview, the fellows continued their exploration of STEM topics, while expanding their professional learning network. Authors interviewed by the fellows included the science popularizers such as Karl Zimmer, Larry Gonick, authors of mathematical fiction such as Gaurav Suri and many others. Instructional support was provided to the fellows both remotely and face-to-face throughout the fall. Finally, instructor and peer feedback mechanisms were used by instructors to support and document fellows' growth and success.

Spring semester: Rocking the Leadership Boat

During the spring Semester, fellows focused on leadership in their academic context as well as what it means to be a leader in STEM education. The discussions in the spring semester were guided by the book *Rocking the Boat: How to effect change without making trouble* by Debra Meyerson. This book explores the idea of “tempered radicals” — i.e individuals who work towards transformational ends through a thoughtful incremental process. In order to explore topics in STEM Leadership, each fellow created a Personal STEM Leadership Manifesto. Based on the spirit of The Personal MBA designed by Kauffman (2010), the Personal Manifesto allowed students to create an annotated bibliography of books, websites, and other resources to use as a foundation for addressing a problem or exploring a question in STEM academic leadership in their personal context. The manifesto was used to help fellows identify instrumental and missional thinking in the school setting, and it also produced memos and blog post designs that encouraged change in some aspect of their academic space. Fellows also presented their work at a special session at the Annual Conference of the American Educational Research Association in Chicago. Additionally, fellows continued to refine their professional web presence and build on their DreamIT projects from the previous semester. These assignments allowed fellows to creatively immerse themselves in various aspects of STEM and leadership as it pertained to their real world experiences as well as directly connecting with leaders in the field.

PROGRAM EVALUATION

There is preliminary data on the impact of the MSU UrbanSTEM & Leadership program on the 25 teachers' ability to develop a classroom experience that enhances the quality of learning. We used four separate instruments to measure this impact: (a) we measured student ability to lead and collaborate among their colleagues with the Educational Leadership Self Inventory (ELSI); (b) we used the Teacher Efficacy Scale (TES) to measure teachers sense of competence in educating their students; (c) we created a technology survey that allowed us to get a better understanding of how proficient the fellows were with using various programs and technology; and finally (d) we used the Technological Pedagogical Content Knowledge (TPACK) scale to assess how effectively the teachers use technology in the classroom and teaching practices.

Teachers' understanding of TPACK allows them to rethink their academic environment and more effectively use technological resources to their advantage (Koehler et al., 2011). Built from the idea of designing and educative experience (Dewey, 1938), first, the fellows were asked to take all four assessments prior to the summer face-to-face educative experience as a pre-assessment. Then, they were asked to retake each assessment in the beginning of the fall semester as a post assessment. The fellows then retook these four assessments at the end of the fall semester, and finally at the end of the spring semester, creating a total of four waves of instrument data. The assessments were used to examine if teachers' leadership qualities, teaching efficacy, knowledge and use of TPACK, and use of technology may have changed as a result of being participants (fellows) in this program.

The preliminary results indicate that participants gained a deeper understanding of TPACK and they developed as overall educators. After completing a one way repeated measures analysis of variance on the first three waves of the TPACK data, we found that there was a significant increase in the overall TPACK of the fellows (see figure 2). Additionally, there was a significant increase in technological content knowledge (TCK) and technological pedagogical knowledge (TPK), which means that our fellows are becoming more effective in implementing technology into their classroom and teaching practices.

A one-way repeated measures ANOVA was conducted to evaluate the null hypothesis that there was no change in scores on the ELSI survey when measured before, after, and further after participation in the program (N=22). We found significant changes in the learning process subscale, as well as the school culture sub scale, but most importantly the overall instrument show statistically significant growth (see figure 3).

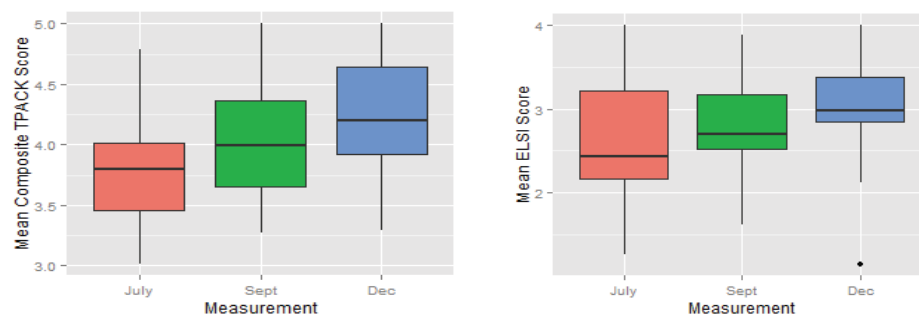


Figure 2: (TPACK) & Figure 3: (ELSI) showing means and standard variations

We ran a one-way repeated measure ANOVA for the Teacher Efficacy Scale (TES) as well. The effects of the TES were greater than that of the ELSI and the TPACK, which could be because of the participants' exposure to new knowledge in general. Finally, we found that there were significant group differences when we completed an ANOVA for the Technology survey.

In addition to the four instruments used in this study, we are completing a qualitative analysis of the Fellow's Dream IT project assignments and from the summer reflections. We have found common themes emerging from our analysis. A few key themes are:

- An emphasis on the role of Aesthetics in STEM teaching and learning
- Focusing on Creativity, both in their practice and thinking of curriculum implementation

- Growth and development in the kinds of Disciplinary Connections being made
- Growth in identity, passion, and philosophy of teaching or learning
- Development of personal Leadership styles and collaboration

Many of these themes were created from the mission of the UrbanSTEM program because we specifically were hoping to find these themes in the Fellows' writing. However, several themes emerged while coding the various documents. Finally, when the Fellows were asked how likely it is that they would recommend the UrbanSTEM program to a friend or colleague (what is known as the Net Promoter Score), the average answer was a 9.6 on a Likert-type scale between 0 (not at all likely) and 10 (extremely likely).

CONCLUSION

All of the different components come together to tell an on-going story about how the participants have not just enjoyed and appreciated the experience but also grown from it. Ongoing analysis and data collection will seek to expand on the data already collected with an eye on better understanding the impact of this fellowship on classroom pedagogy. The research evolving from this program specifically supports its influence on teacher professional development and leadership in STEM. Furthering teacher's capacity to integrate technology into their pedagogy and increasing teacher competence can have a great impact on student learning and engagement (Harris & Sass, 2011), especially for students of color in STEM topics (Museus, Palmer, Davis & Maramba, 2011). A more competent and diverse teacher can also influence other dynamics that play a crucial role in urban school settings, such as the racial achievement gap or the SES achievement gap. Additionally the focus on leadership encourages the fellows to share their knowledge and ideas thus creating a community that practices the creative integration of technology in the classroom.

References

- Blumenfeld, P., Fishman, B. J., Krajcik, J., Marx, R. W., & Soloway, E. (2000). Creating usable innovations in systemic reform: Scaling up technology-embedded project-based science in urban schools. *Educational Psychologist, 35*(3), 149-164
- Dewey, J. (1938). *Education and experience*. New York: Kappa Delta Pi.
- Guskey, T. R. (1990). Integrating innovations. *Educational Leadership, 47*(5), 11-15.
- Goldhaber, D. (2002). The mystery of good teaching: Surveying the evidence on student achievement and teachers' characteristics. *Education Next, 2*(1), 50-55.
- Harris, D. N., & Sass, T. R. (2011). Teacher training, teacher quality and student achievement. *Journal of Public Economics, 95*(7), 798-812.
- Kaufman, J. (2010). *The personal MBA: A world-class business education in a single volume*. Verlag: Portfolio Penguin.
- Koehler, M. J., & Mishra, P. (2008). Introducing TPACK. In AACTE Committee on Innovation & Technology (Eds.), *Handbook of technological pedagogical content knowledge for educators* (pp. 3-29). New York: Routledge.
- Koehler, M. J., Mishra, P., Bouck, E., DeSchryver, M., Kereluik, K., Shin, T. S., & Wolf, L. G. (2011). Deep-play: Developing TPACK for 21st century teachers. *International Journal of Learning Technology, 6*(2), 146-163.

- Michigan State University MSU-Wipro STEM Fellows. (2014) Roots of STEM: A collection of lesson plans, for teachers, by teachers. Retrieved from <http://www.msuurbanstem.org/teamone/wp-content/uploads/2014/09/Roots-of-STEM-book.pdf>
- Mishra, P., & Koehler, M. J. (2006). Technological Pedagogical Content Knowledge: A new framework for teacher knowledge. *Teachers College Record* 108(6), 1017-1054.
- Mishra, P., Koehler, M., & Wolf, L. G. (2012). The educational psychology and educational technology program. Retrieved from <http://punya.educ.msu.edu/wp-content/uploads/2013/02/AACTE-TechnologyAward-MichiganState.pdf>
- Museum, S. D., Palmer, R. T., Davis, R. J., & Maramba, D. C., (2011). Special Issue: Racial and ethnic minority students' success in STEM education. *Association for the Study of Higher Education*, 36, 1-140.
- Swenson, J., & Mitchell, D. (2006). *Enabling communities and collaborative responses to teaching demonstrations*. Red Cedar Writing Project, Michigan State University.
- Tajalli, H., & Ophiem, C. (2004). Strategies for closing the gap: Predicting student performance in economically disadvantaged schools. *Educational Research Quarterly*, 28(4), 44-54.
- Terry, L., Mishra, P., Henriksen, D., Wolf, L. G., & Kereluik, K. (2013). Making it meaningful: The reciprocal relationship between technology and psychology. *TechTrends*, 57(3), 34-39.
- Wolf, L. G. (2009, Aug. 19). Quickfires explained. Retrieved from <http://www.leighgraveswolf.com/2009/08/19/quickfires-explained/>
- Wolf, L. G. (2011). Faculty versus student perceptions of the quality and relevance of a master's degree in educational technology (Order No. 3489755). Available From Dissertations & Theses @ CIC Institutions. (915788795).