Student Success as a Function of Entrepreneurial Teacher Leadership in STEM Teaching and Learning: A Working Model

Fouad Abd-El-Khalick, Janet S. Gaffney, Raymond L. Price, Jeanne Koehler, Anita M. Martin
University of Illinois at Urbana-Champaign

Abstract

There have been increasingly urgent and well justified calls for transforming precollege education for the purpose of maintaining the US competitiveness and leadership in science, technology, engineering, and mathematics (STEM). Central to such a transformation, we believe, is a new generation of entrepreneurial STEM teacher leaders empowered with the mindset and skills to envision, enact, and realize innovations aimed at improving learning for all students. In this session, an interdisciplinary research team attempts to integrate multi-threaded conceptual and empirical studies aimed at building theory for informing systemic, long-term professional growth programs and partnerships aimed at developing entrepreneurial K-12 STEM teacher leaders which will ultimately increase opportunities for student success in STEM education.

Section 1: Questions for dialogue at the MSP LNC

Within the literature on entrepreneurship, only a small portion is devoted to this construct within the K-12 school setting and within this subset there are only broad visions of its application and potential promise. Importantly, then, the EnLIST team is continually working to refine our knowledge and understanding of the skills and mindsets that are necessary to enable innovation and transformation that ultimately leads to student success in STEM teaching and learning, both through research and through the practical application of our research to the EnLiST teacher leaders within our core school partner districts.

The EnLiST leadership team welcomes discussion around the following questions related to the notion of student success in STEM education.

- In which ways should student success in the STEM areas be conceptualized to contribute meaningfully to increased participation in STEM?
- How should we conceptualize 'increased participation' in STEM to ensure inclusiveness and equitable engagement of all students?

These and other questions may facilitate discussions that will prove fruitful as the EnLiST leadership team moves forward in conceptualizing what student success looks like in an educational entrepreneurship environment.

Section 2: Conceptual Framework

The National Science Board (2001) affirmed that the prosperity and advancement of the scientific enterprise in the 21st century will, to a large extent, determine the economic growth, quality of life, and the health and security of our nation and the planet. The prosperity of this enterprise, in turn, hinges on the preparation of highly qualified, diverse, and motivated learners at every stage of the academic pipeline. U.S. precollege STEM education—a cornerstone to this pipeline is not accomplishing the necessary results (NCMST, 2000). Students continue to perform poorly on international comparisons of science and mathematics achievement (National

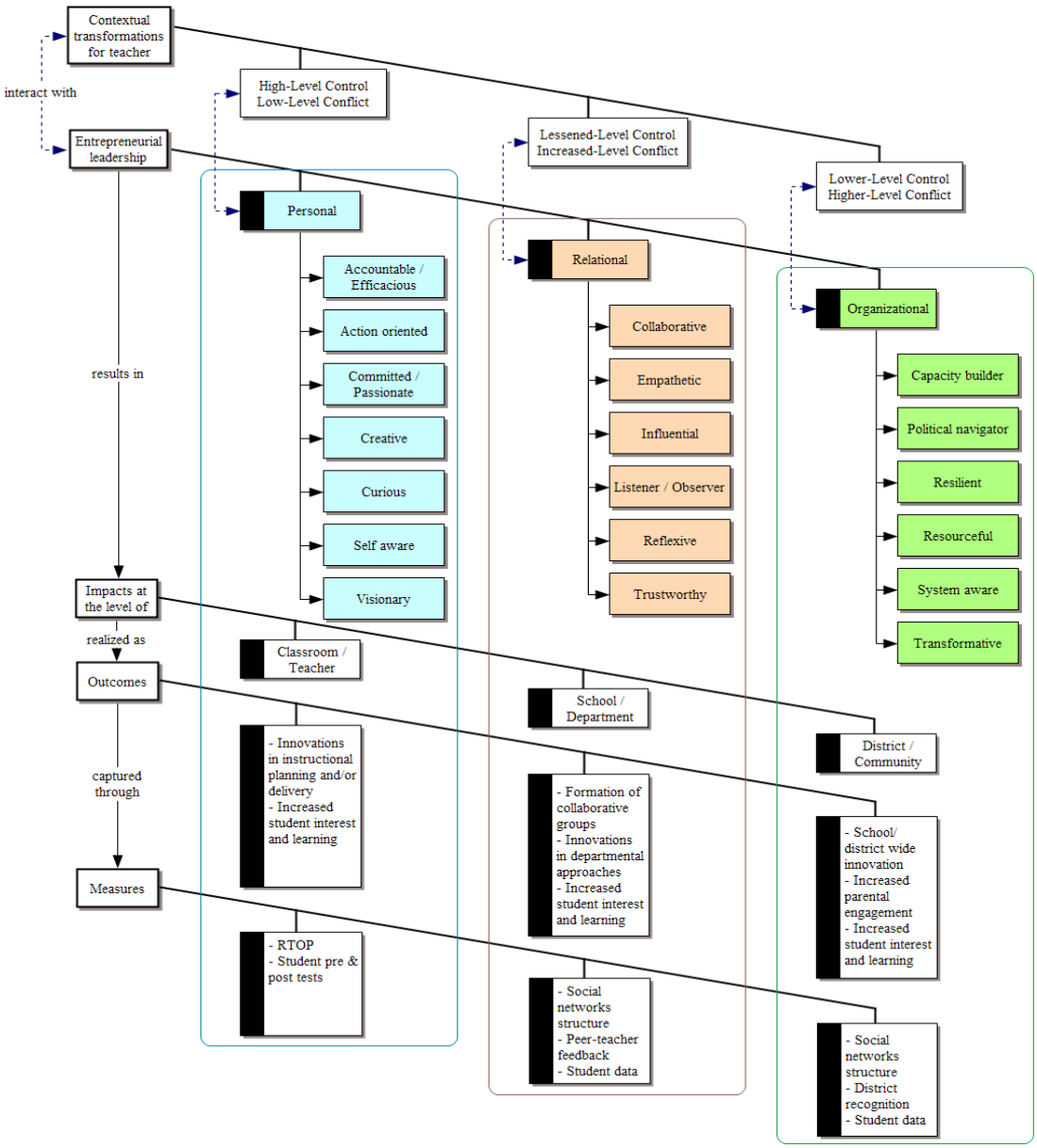
Center for Education Statistics, 2000, 2004, 2008) and the system continues to fail girls, and minority and underprivileged students (Lee & Luykx, 2006). There is an urgent need for transforming K-12 STEM education (CPGE, 2007). Central to such transformation, we believe, is the preparation of a new generation of entrepreneurial STEM teacher leaders empowered with the understandings, mindset and skills to envision, enact, and realize innovations aimed at improving learning for all students. The preparation of such leaders is the central goal of the Entrepreneurial Leadership in STEM Teaching and learning (EnLiST) MSP partnership.

While recent, the notion of infusing and capitalizing on entrepreneurship in K-12 schools is not entirely new (Hess, 2006). Scholarship in this domain, however, has been limited and mostly centered on broad conceptualizations of the potential promise and returns of such an approach, and narratives of individual, highly visible educational entrepreneurs. In contrast, EnLiST draws on scholarship in business and social entrepreneurship, social networks, and educational leadership to build and test new models or developing entrepreneurial STEM educators from the ground up by embedding our research in the daily work of teaching and learning in schools. Our focus is on professional development of STEM educators as leaders who promote sustainable, collegial, collaborative interactions that result in the implementation of innovative practices. STEM teacher leaders must have to the opportunities to develop the entrepreneurial thinking and practices that are needed to lead such efforts. The bottom line measure of the value of these endeavors is the engagement and success of students in science. Importantly, then, within the EnLiST project, student success is defined as any set of cognitive (e.g., scores on standardized tests such as ISAT's or PSAE) and/or affective outcomes (e.g., interest, willingness to engage, and appreciation) that enhance the likelihood of students pursuing additional STEM studies and meaningful engagement with STEM both within and outside academic settings.

Toward this end, an interdisciplinary team with research expertise in teacher leadership, enterprise and systems engineering, science education, entrepreneurship in business and higher education, and social networks has embarked on a long-term collaboration. This session provides a forum both to share our current conceptual and empirical work in this area—which we believe is both novel and promising, and engage in public discourse with interested scholars and colleagues for valuable feedback, critique, and fertilization of ideas.

EnLiST Model Development

As part of the EnLiST project, we were given the opportunity to think about entrepreneurial leadership in STEM teaching and learning (Koehler, Price, Gaffney, Bresler, Abd-El-Khalick, & Martin, 2009). Figure 1 outlines the initial model that conceptualized the personal, relational, and organizational skills and capabilities that would be required to make innovative changes in the classroom, among colleagues, and in schools and school districts.



Section 3: Explanatory Framework

Key insights

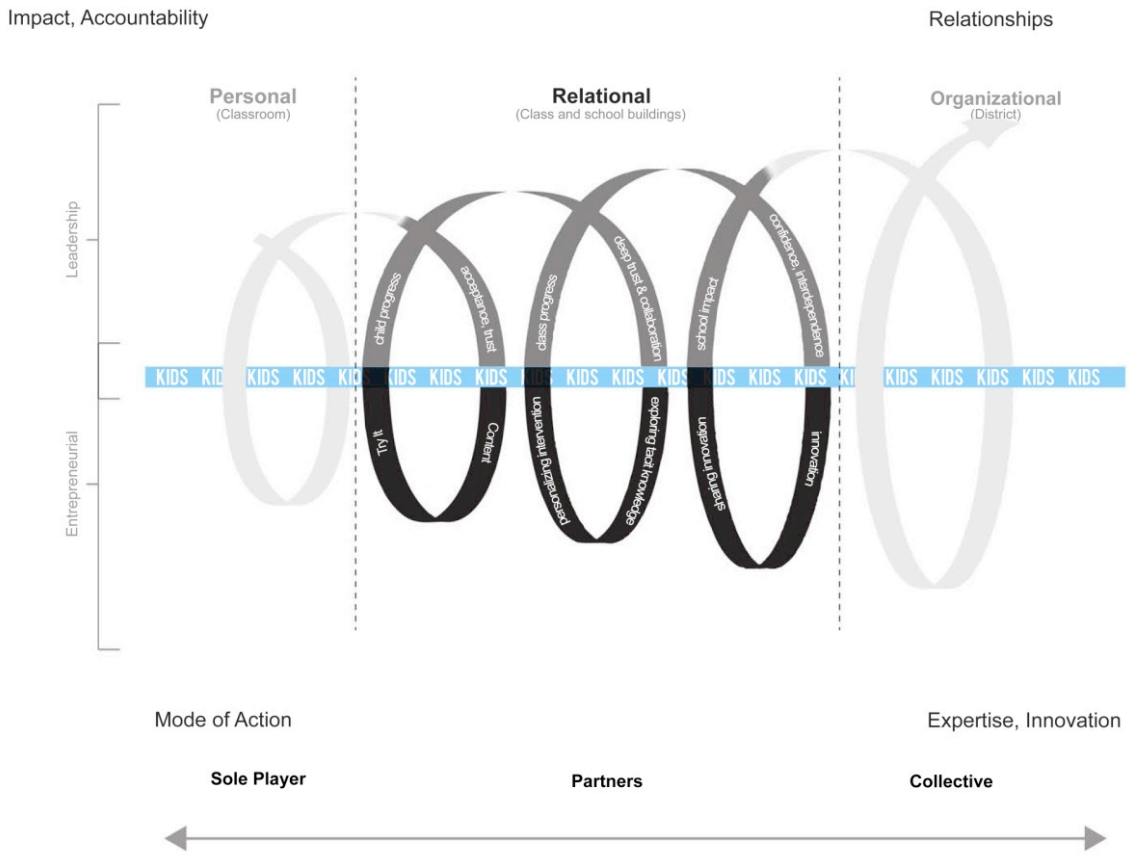
Given the limited research on entrepreneurial educators, we conducted a case study of four 'entrepreneurial' teachers in a suburban central Illinois district; teachers identified as leaders who were taking considerable risks and who were having an impact on students, other teachers, and their schools. The study consisted of two interviews with each of the teachers and at least one focus group with collaborating teachers—a total of four entrepreneurial teacher leaders and 25 teachers in their realm of influence. The purposes of the study were to: 1) explore the characteristics described in Figure 1 to determine which are most important; 2) understand examples of the desired behaviors to guide the development of the workshop that was presented in the summer of 2010; and 3) enhance the entrepreneurial teacher leader model and framework.

The characteristics were important, but not near as important as the actions that catalyzed and galvanized teachers as they collaborated to improve student learning. The personal characteristics and the "habits of mind" are important for both the entrepreneurial teacher leader and for the teacher who is working to improve.

Our interviews revealed a model (see Figure 2) that shows how entrepreneurial teacher leaders collaborate with other teachers in ways that catalyze innovations that result in student progress. At the **heart of the model is a focus on children and their learning and success**. When the focus of both the teacher and the teacher leader is on children, the emphasis is not on the teachers and their skills or what they do well or do poorly; the common goal is the child's learning and progress. Having the child's success as the common objective lessens the tension and the defensiveness that can enter into the coaching or helping relationship (Schein, 2009).

The other critical elements of the model include: (1) a dynamic cycle of sharing, learning and improving that changes significantly over time; (2) relationships are the entre to professional collaboration and the fabric that grows into trust and confidence of all parties; (3) sharing of content and expertise that improves children learning and that engages the teachers in learning and innovation; (4) teacher actions that make the content and expertise their own; and (5) impact on children, classrooms and schools.

Leadership is about influence and learning. Not surprisingly, we found relationships that start with a modest level of trust before there can be any influence or learning. Those relationships develop into deeper trust and collaboration which enables the relationship to transform into confidence and interdependence. The relationship becomes stronger and more powerful as content is shared, the interventions or practices impact child progress and then the relationship deepens and changes. We assert, that professional development efforts that keep the teacher leader as the expert and the source of knowledge are doomed to failure in the long-term.


Impact, Accountability
Relationships
Personal
(Classroom)
Relational
(Class and school buildings)
Organizational
(District)
Leadership
Entrepreneurial
child progress
acceptance, trust
Try It
Content
class progress
deep trust & collaboration
personalizing information
exploring best knowledge
school impact
confidence, interdependence
sharing innovation
innovation
KIDS
Mode of Action
Expertise, Innovation
Sole Player
Partners
Collective

Powerful learning starts with the explicit content and methods and then transforms to capture the subtle, tacit factors that enable methods to work effectively for specific cases. As teachers gain the tacit understanding, they progress from trying methods to making the methods their own (see Figure 2). They may personalize the methods or integrate them into their repertoire so that they own the methods and are able to apply them to other students and situations. With a growing comfort with and ownership of methods, teachers begin to innovate in ways that extend the power and impact of the interventions (Hagel, Brown, & Davison, 2010). Improvement starts with child progress and naturally extends to the classroom as teachers learn, gain confidence, and make the methods their own. In our model, it should be noted, assessment is an integral and natural part of "knowing" and of being able to tell what works and what does not work.

Transition of skills and knowledge that is sufficiently powerful to impact student learning may start with simple sharing of content but, in order to transform a teacher, a classroom and a school personalizing of the methods and innovation have to take place. Facility with the methods and ownership that comes with modifying them, making them your own, and then innovating to improve the methods and techniques are essential for technology transfer that works and lasts.

Teachers are very pragmatic; they want methods, activities, and techniques that work. Work means that methods make a tangible difference in the students' progress. If a method is tried and if it helps the child progress, then the receiving teacher is ready and willing to take the next steps. Often, there will have to be coaching and collaboration to ensure that the methods are applied correctly and to "see" how the child is progressing. Every teaching method or technique needs to be understood completely and modified to fit the new teacher and the situation. Once those conditions are met, we can claim to have successful technology transfer. Then the relationship changes to one where there is confidence and interdependence and the partners are able to innovate and share with others.

Evaluation

As we have learned more about entrepreneurial teacher leaders, we have begun to understand the relational elements or partnerships that form to enable one teach to influence another. In our model, the leadership portions include: 1) the relationship development and 2) child progress and accountability. Without a positive starting relationship and unless that relationship deepens and transforms, there is no real "technology transfer." These behaviors of relationship building are critical for leadership to occur and to enable the content to be received well. Without the child as the central focus and the measure of progress being the success of the child, there is no accountability and there is no power in the relationship to transform the situation. Progress is critical and it is always child progress—not teacher development, knowledge or skills—that is the critical focus. Teacher skills are important, but they are the means not the end goal. Student success within this model then is assessed by annual administrations of the MSP Student Motivation Survey and student performance tracking on the Illinois Standards Achievement Test (ISAT) science subtest at classroom and school levels. In addition, qualitative data from case studies will provide additional support to our claims regarding student success in STEM teaching and learning.

The entrepreneurial portions of the model include: 1) expertise to share and then the ability to innovate and keep learning and developing, and 2) the willingness to try it, personalize it, and then share the new innovations. Unless there is some foundation of expertise in knowledge, approach, techniques, or methods, there is not a strong starting point. Often that expertise is seen by others and is valued. Usually, that expertise or content knowledge has been gained because of curiosity, deep learning, innovating, and taking some risks. But once entrepreneurial teachers acquire those skills and abilities, they keep innovating, learning, and sharing. There is always some risk in adopting anything new, making it your own, and innovating. Entrepreneurial action embodies some risk and requires flexibility in thinking and exploring (Sarasvarthy, 2010)

Informing EnLiST

The team continues to work and to refine our knowledge and understanding—both through research and through the practical application of our research to the MSP teachers. One of our next goals is to refine our definition of entrepreneurial STEM teachers. In the spirit of learning and collaboration, a working definition is included:

> "Working in contexts that are (or justifiably perceived to be) resource-deprived, entrepreneurial STEM teachers succeed in creating innovative and transformative learning opportunities or environments, both within and beyond their own classrooms, such that the quality and quantity of students' STEM learning experiences and outcomes are markedly better than the actual or perceived norms of their milieu."

The ultimate goal is student learning and success. The methods are creative, innovative, and transformative. We will continue our collaboration with teachers to learn and to develop the skills and abilities that can produce the behaviors that we observe that support our vision of student success.

References

Bornstein, D. (2007). *How to change the world: Social entrepreneurs and the power of new ideas* (Rev. ed.). New York: Oxford University Press.

Bresler, L. (2009). The academic faculty as an entrepreneur: Artistry, craftsmanship and animation. *Visual Art Research, 35* (1), 12-24.

Burt, R. (2004). Structural holes and good ideas. *American Journal of Sociology, 110*(2): 349-399.

Childress, S., Barr, S., Johnson, K., Kopp, W., & Rhee, M. (Producer). (2008, January 13, 2010). The role of social entrepreneurship in transforming U.S.A. public education. *The Business Summit*. Retrieved from http://www.hbs.edu/centennial/businesssummit/business-society/the-role-of-social-entrepreneurship-in-transforming-usa-public-education-1.html

Cohen, W., & Levinthal, D. (1990). Absorptive capacity: a new perspective on learning and innovation. *Administrative Science Quarterly, 35*, 128-152.

[CPGE] Committee on Prospering in the Global Economy of the 21st Century: An Agenda for American Science and Technology, National Academy of Sciences, National Academy of Engineering, Institute of Medicine. (2007). *Rising above the gathering storm: Energizing*

and employing American for a brighter economic future. Washington, DC: National Academy Press.

Hagel, J., Brown, J. S., & Davison, L. (2010). *The Power of pull: How small moves, smartly made, can set big things in motion*. New York: Basic Books.

Hargreaves, A., & Shirley, D. (2009). *The fourth way: The inspiring future for educational change*. Thousand Oaks, CA: Corwin.

Hess, F. M. (Ed.) (2006). *Educational entrepreneurship: Realities, challenges, possibilities.* MA: Harvard Education Press.

Fullan, M. (2010). *All systems go: The change imperative for whole system reform*. Thousand Oaks, CA: Corwin.

Koehler, J. L., Price, R., Gaffney, J., Bresler, L., Abd-El-Khalick, F., & Martin, A. (2010, January). *EnLiST: Developing entrepreneurial teacher leaders.* Paper presented at the 2010 Math-Science-Partnerships Learning Network Conference, Washington, DC.

Lee, O., & Luykx, A. (2006). *Science education and student diversity: Synthesis and research agenda.* New York: Cambridge University Press.

Mort, G. S., Weerawardena, J., & Carnegie, K. (2003). Social entrepreneurship: Towards conceptualization. *International Journal of Nonprofit and Voluntary Sector Marketing, 8*(1), 76-88.

National Center for Education Statistics, U.S. Department of Education. (2000). *Pursuing excellence: comparisons of international eighth-grade mathematics and science achievement from a U.S. perspective, 1995 and 1999*. P. Gonzales, C. Calsyn, L. Jocelyn, K. Mak, D. Kastberg, S. Arafeh, T. Williams, & W. Tsen. NCES 2001–028. Washington, DC: U.S. Government Printing Office.

National Center for Education Statistics, U.S. Department of Education. (2004). *Highlights from the trends in international mathematics and science study (TIMMS) 2003*. P. Gonzales, J. C. Guzman, L. Partelow, E. Pahlke, L. Jocelyn, D. Kastberg, & T. Williams. NCES 2005 – 005. Washington, DC: U.S. Department of Education.

National Center for Education Statistics, U.S. Department of Education. (2008). *Highlights from TIMMS 2007: Mathematics and science achievement of U.S. fourth and eighth-grade students in an international context.* P. Gonzales, T. Williams, L. Jocelyn, S. Roey, D. Kastberg, & S. Brenwald. NCES 2009–001. Washington, DC: U.S. Department of Education.

[NCMST] National Commission on Mathematics and Science Teaching for the 21st Century (2000). *Before it's too late.* Jessup, MD: Education Publications Center

National Science Board. (2001). *Toward a more effective role for the U.S. government in international science and engineering.* Arlington, VA: National Science Foundation.

Sarasvathy, S. D. (2010). *What makes entrepreneurs entrepreneurial?* Retrieved from Social Science Research Network http://ssrn.com/abstract=909038

Schein, E. H. (2009). *Helping: How to offer, give and receive help*. San Francisco: Berrett-Koehler.