

A Systems Solution for Engaging Learners in STEM Learning

Dr. Anthony Betrus

Mr. Steven Canning

Mr. Marshall Hughes

Representing the State University of New York at Potsdam

And

The National Education Foundation

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Abstract: STEM Education is a critical component of high quality 21st-century education, but increasing demands are placed on teachers to prepare students for state and federal exams. This paper will detail three model public school districts that are currently using individualized digital tutors as a tool to reduce the classroom time that test preparation takes, allowing teachers to engage their students in real-world, problem-based STEM learning activities.

## The Importance of STEM Learning

Science Technology Engineering and Mathematics, or STEM, along with its many variations (STEAM, eSTEM, STEMM, etc), represents a movement in the United States to expose students to 21st century learning environments (White House, 2016). In our evolving technological world, students need to acquire STEM skills to be college and workforce ready, even if they are not going to be an engineer or scientist. These resources come in different forms, such as programmable robots, sandbox style video games, building tools, and virtual and augmented reality devices. These learning materials give students a chance to problem solve and to be creative in ways that traditional textbooks and testing can not measure. Unfortunately, there currently exists a tension between preparing for high-stakes end-of-year testing, and allowing time for exploration of relevant 21st century skills for students. This paper outlines the aggregate experiences of three public schools that have managed, with only a small amount of outside help and a lot of creativity, to square this circle, ensuring high performance on end-of-year tests, as well as allowing the freedom for teachers to engage their students in problem-based STEM learning.

## Common Core and State Testing

While there are currently over 20 schools participating in the NEF STEM+ Academy program, the three schools we are focussing on are Canton Central School District in Canton, NY; Steubenville City Schools in Steubenville, OH; and Martins Ferry City School District in Martins Ferry, OH. All three are small-to-moderate sized school districts with relatively limited resources. Schools around the country continue to focus on student testing, and recently on teacher evaluations (Educational Leadership, 2016). Finding their teacher evaluations tied to student performance, the teachers in these districts found themselves in an untenable situation: they felt that while

previously there may have been time to explore new and relevant topics not directed by the state testing requirements, preparing students now took up virtually all of their classroom time.

Intentional or not, the cultural shift to double-down on high-stakes testing and teacher evaluations has in many ways hurt the public school system, in many cases reducing teaching to a lowest common denominator: "The Test."

### People and Organizations Willing to Help

Rather than giving in to the status quo, the teachers at these three schools sought outside help and received funding from local businesses, nonprofits, and other sources to provide individualized digital tutors and STEM learning for students at different grade levels in each of the districts (Batt, 2016). A local private foundation provided partial funding for Canton, while Steubenville and Martins Ferry used funds from their own district budgets. The remainder of funding came from a mix of grants, donations, and nonprofit partnerships. The graduate program in Educational Technology at The State University of New York at Potsdam partnered with one of these nonprofits, and worked with these districts to provide professional development and logistical support in managing the implementation of the individualized learning system. The program the teachers from these districts have implemented represents some of the best ideas from the sixteen STEM+ academies in ten states around the country (Canning, 2016).

### A "Systems Solution"

Our approach acknowledges and works with the idea of a school district as an integrated system of students, teachers, parents, administration, and community members, and provides tools for all of these groups: the parents and community are provided with professional development software, allowing them to build their skills in IT, Business, and Desktop Applications; the

administration is provided with additional funding and teacher development; the teachers are given access to 21st century learning tools; and the students are provided personalized learning software that is customized to their own particular strengths and weaknesses. Students are also provided with motivational incentives, including Olympic Style Leaderboards, individual rewards, and group-based rewards, all based on their performance. Because performance is measured by their gain over their initial benchmark, students of all abilities are competing on a relatively level playing field.

### Conclusions

In the three years since we have begun working with these districts we have seen a strong positive correlation between the students' performance in the individualized learning software and their state test scores in both Math and Reading. For instance, at Canton, 100% of the students who were at or above grade level in Math and Reading in the learning system at the time of their state test passed that test. Similar results were found at the other two schools as well. When armed with some clarity and assurance of their students' state test scores, the teachers felt less obligated to "teach to the test" and started introducing more and more STEM learning activities in the newly created free time, such as K'Nex building tools, Snap Circuits, Minecraft software, and programmable robots into their classrooms. The students, as might be expected, were thrilled, so much so that many asked their parents for these tools and kits as Christmas gifts.

The system quickly became self-reinforcing, as access to STEM learning was predicated on student performance in the individualized digital tutoring system. As students succeeded in the tutoring system, they gained access to STEM learning activities; the more they engaged in those

activities, the more they wanted to continue with them, which spurred them to continue to strive to do well in the tutoring system to secure this access. Because the individualized tutoring software is scaffolded to state standards, their performance on the state tests increased.

Regardless of which is more important - the state test scores of the engaged student learners - what was previously seen as an issue of either-or was transformed into a yes-and.

Because the systems at these schools communicate with each other through their University and nonprofit partners, the change seen in these schools is spreading to other school districts and states. New partner schools are already learning and replicating their success, and while the fundamentals of the system are the same, each school has a unique way of putting the pieces together. Changing the systems in three local systems is but a start: a proof-of-concept showing that performance on state tests and 21st century STEM learning can coexist and complement each other. The next step is to share these results with other stakeholders, and to continue on the mission that President Barack Obama set forth for universities and schools, that is to make students "...more excited than ever about pursuing their passions for STEM." (Ransom, 2016).

## References

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