JournalNX- A Multidisciplinary Peer Reviewed Journal
ISSN: 2581-4230, Website: journalnx.com, June 18th & 19th, 2020

BUILDING STEM IN SAMARQAND, UZBEKISTAN WITH A DAST FULBRIGHT FELLOW

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Abstract. From January through March, 2020, the co-authors worked together at the Samarqand Institute for Teacher Recertification, providing a cohort of teachers with intensive training to become STEM coaches. Allan was a DAST Fulbright Fellow providing STEM expertise from the US and Dilbar is the Assistant Director at the Institute who organized the project. Allan worked with a cohort of 25 teachers for 5 weeks introducing them to STEM principles from the US systems and training them to become STEM coaches for area teachers. Allan was also able to visit multiple general schools in the Samarqand region, as well as the Presidential School in Khiva for teacher presentations and model lessons. This paper is a summary of the project, presented in the hopes that it can provide inspiration for similar work throughout Uzbekistan.

How the project came to be:

The Fulbright Distinguished Awards in Teaching Short-Term Program for U.S. Teachers is sponsored by the U.S. Department of State with funding provided by the U.S. Government and administered by IREX. Fulbright DAST sends expert U.S. K–12 teachers and educators to participating countries to support projects identified by U.S. embassies and Fulbright commissions in schools, teacher training colleges, government ministries, or educational nongovernmental organizations. Interested American Teachers apply to participate in projects and are selected by Fulbright Staff to serve in countries around the world including Uzbekistan.

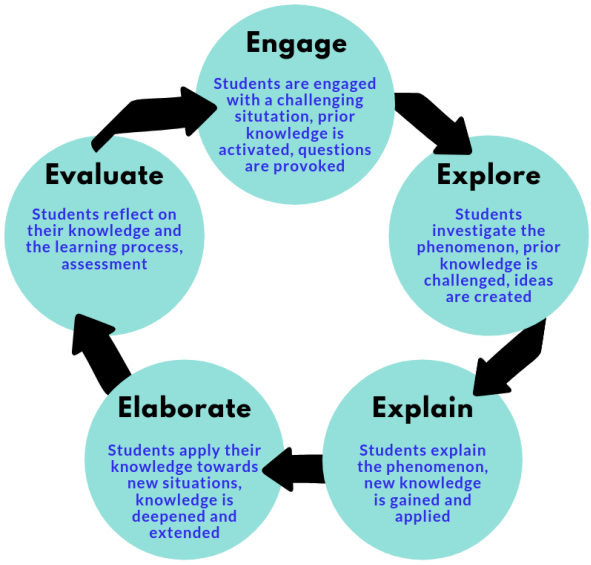
What is STEM – and what Allan taught:

Perhaps the biggest challenge from Allan's perspective was determining what to teach since STEM or even STEAM is such a broad, almost ambiguous concept. The simple definition of Science, Technology, Engineering, (Art), and Math doesn't really explain how that would look any different from what is happening now in schools all over the world. During his time in Uzbekistan he found that some teachers think STEM is just really rigorous instruction of facts, or a focus on computer coding, or even the shifting of all science instruction to happen in English. So the first step was really to make a decision about what would be most helpful to begin to move STEM student learning forward in the country based on what we have learned and developed in the US. For the past 15 years, STEM education in the United States has undergone a tremendous reformation and the outcome is that many states, including Alaska and Vermont where Allan has taught, are now aligned with a national science standards framework called the Next Generation Science Standards or NGSS. At the core, NGSS is a framework

that breaks successful science education down into three elements. One is the content – the actual facts and academic knowledge that forms the foundation of scientific understanding. Years of hard work have even broken these facts down into grade level content expectations that clearly state what concepts and themes should be taught at each grade level.

Having taught in the Soviet Union in 1998 in Rostov-na-Donu, Allan had a pretty thorough understanding of the Russian national curriculum that is still the foundation of curriculum in Uzbekistan. He also understood that within the national curriculum teachers are not really given the time or freedom to decide to skip or add various topics – and with national textbooks and lesson plans these content decisions had already been made. The teachers didn't need any help deciding what physics to teach in 2nd grade or what earth science to teach in 6th. So he decided the idea of actual STEM content was not an area to focus on during this initial phase of the work

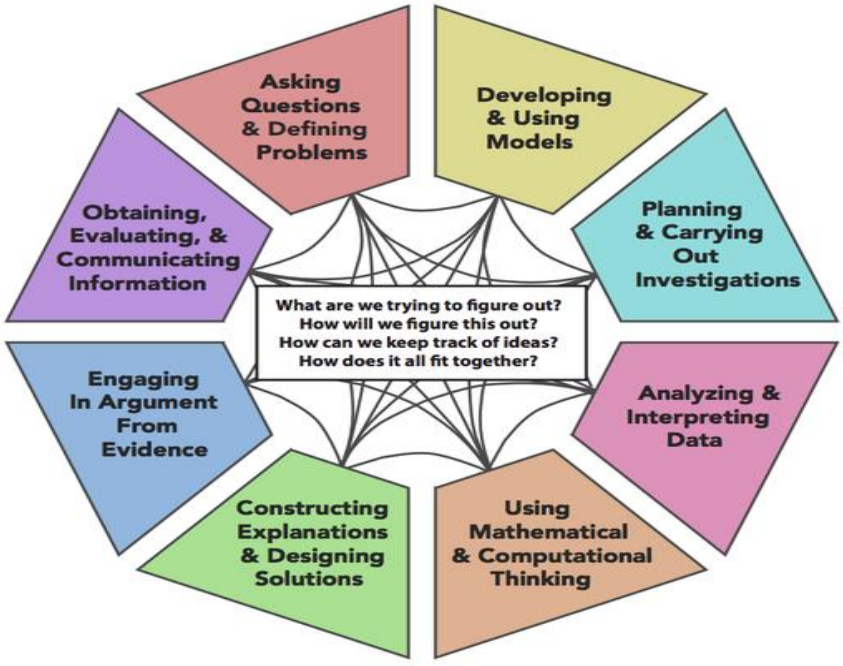
Another possible element to consider is how to design an effective science lesson or unit, which within the NGSS is often called the Five E design, an acronym that stands for Engage, Explore, Explain, Elaborate and Evaluate. This lesson design is used as the basic structure for creating and delivering an effective unit of instruction that is aligned to the NGSS.



This framework applies to far more broadly than just science – it is a compilation of psychology, neuroscience and pedagogy on how best to engage students and help them learn. It can and is also taught in the US as a framework for effective instruction in mathematics, world language, social studies and many other curricular areas. In the US, teachers are given the freedom (and responsibility) to design their own lessons. There are full curriculums, sets of lessons that teachers and schools can purchase that follow the 5 E design and provide a rigid set of step by step instructional steps – however most schools and teachers pull from a wide variety of resources (textbooks, online materials, project ideas, etc) in order to determine how they are going to teach the specific concepts that they are responsible for at their grade level. Again drawing on his experience with the national curriculum in the USSR / Russia – it was

clear to Allan that lesson design was also not in the control of individual teachers who are given a textbook and lesson sequence they are expected to follow. So this area was also determined to not be an area of focus for this first phase of the work, although it will certainly be very important in order to move STEM learning forward in the country.

That left the 8 Science and Engineering Practices and an exploration of how they can be integrated into lessons that currently focus primarily on teaching and assessing content – and this became the entire focus of Allan's work with the group of potential Uzbek STEM coaches. He made the entire goal of the project that teachers would begin to understand the US approach that is grounded in a belief that although science content / facts are important, it is equally or perhaps more important to provide students the opportunities to practice and learn the skills that the foundation of being a scientist – the 8 Science and Engineering Practices. Throughout the six weeks, it became more and more apparent that this was an excellent place to start – helping teachers develop a new paradigm that shifts their focus from what facts they teach and students know, to what can do with that information. These 8 Science and Engineering Practices are listed below – it is important to note that they are not meant to be listed in any sort of priority order – they are all important and do have significant overlaps as we begin to think about what it means for them to be the basis of a lesson.



NGSS

Developing and Using Models - A practice of both science and engineering is to use and construct models as helpful tools for representing ideas and explanations. These tools include diagrams, drawings, physical replicas, mathematical representations, analogies, and computer simulations.

Asking Questions and Defining Problems A practice of science is to ask and refine questions that lead to descriptions and explanations of how the natural and designed world works and which can be empirically tested.

Planning and Carrying Out Investigations Scientists and engineers plan and carry out investigations in the field or laboratory, working collaboratively as well as individually. Their investigations are systematic and require clarifying what counts as data and identifying variables or parameters.

Analyzing and Interpreting Data Scientific investigations produce data that must be analyzed in order to derive meaning. Because data patterns and trends are not always obvious, scientists use a range of tools—including tabulation, graphical interpretation, visualization, and statistical analysis—to identify the significant features and patterns in the data. Scientists identify sources of error in the investigations and calculate the degree of certainty in the results. Modern technology makes the collection of large data sets much easier, providing secondary sources for analysis.

Using Mathematics and Computational Thinking In both science and engineering, mathematics and computation are fundamental tools for representing physical variables and their relationships. They are used for a range of tasks such as constructing simulations; statistically analyzing data; and recognizing, expressing, and applying quantitative relationships.

Constructing Explanations and Designing Solutions The products of science are explanations and the products of engineering are solutions.

Engaging in Argument from Evidence Argumentation is the process by which explanations and solutions are reached.

Obtaining, Evaluating, and Communicating Information Scientists and engineers must be able to communicate clearly and persuasively the ideas and methods they generate. Critiquing and communicating ideas individually and in groups is a critical professional activity.

For more information about these core ideas of the Next Generation Science Standards and specifically the connections between content standards, pedagogy and the science practices, the following are sites that teachers throughout the US use to guide their STEM instruction.

NGSS – Overall Website – this is the primary source for all information about the Next Generation Science Standards. Specifically searching the site based on any of the 8 Practice will lead to great information. There is also much about the specific knowledge and learning that each grade level in the US is expected to use as students practice and demonstrate these skills.

National Science Teacher's Association (NSTA) NGSS Hub – this is the primary resource guiding professional development for US teachers as they learn how to use NGSS and the 8 Skills in their classroom.

Making Sense with NGSS Science Practices – an incredible resource in .pdf form that explains what each of the 8 practices looks and sounds like in the classroom with many clear examples.

It is important to note that defining "what is STEM?" is likely the greatest challenge still to be tackled before UZB can make a significant step forward in their STEM education improvement. The definition Allan chose is one that made sense based on his experience and what he perceived to be the needs and interests of the teachers that he worked with during his time in Samarqand. He does sincerely believe that in the 21st century what is most important is not "what you know" but "what you can do with what you know" and that requires a fundamental shift in how we teach STEM subjects. That thinking is widespread throughout the education community in the United States and is at the core of the Next Generation Science Standards. Every that follows in terms of the program that was created and followed during his time in Samarqand is based on that thinking.

How the project was organized:

Here is a very simplistic summary of Allan's work during the 6 weeks he was in Samarqand:

Week 1 – Allan presented an introductory lecture to all institute staff and teachers, followed by 3 days of instruction with institute staff exploring "What is STEM?" This was possible as it was the last week of January and the new teachers which would be the primary focus of his work didn't arrive until the second week.

Weeks 2 – 3, Allan worked for approximately three hours every day with 25 teachers drawing from 19 different Samarqand area schools and representing 16 different subjects / grade levels. An incredibly diverse group representing just about every teaching assignment that typically enters the institute. This was a very unusual arrangement for the institute,as typically the teachers are organized in a cohort of subject area specialists – ie. 25 math teachers, English, geography, etc. This was necessary since teachers needed permission from their administration and the Institute to vary their typical 144 hours of very structured teacher instruction. These were the 25 that both had permission and were interested in exploring STEM. Although it happened by chance – it really helped to have such a diverse group and allowed Allan to focus on the broad concept of utilizing the 8 NGSS Scientific Practices and Skills rather than just STEM integration in a particular subject area or grade level.

Week 4 – During this week the newly trained teachers taught model STEM lessons in 2 area schools – School #51 and School #13, chosen because their Directors were willing to radically adjust the student experience for the week and were interested in learning about STEM for themselves and their teachers. Each lesson was observed by at least 15 teachers and at the end of each day we held an analysis / debriefing session. Great week of growth to move teachers beyond theoretical to practical.

Week 5 – Allan concluded their training as STEM teachers by reviewing the lessons and exploring where these methodologies could be expanded in their instruction, and specifically how the focus on the 8 Scientific Practices could fit into the very structured UZB National Education Program / Curriculum. Since nearly every day is in the national curriculum is clearly defined to the minute, these teachers were given permission by their Directors to break from that program but they will continue to use the National Assessments in order to see whether

their pedagogy has any effect on student engagement and learning, which we all are confident it will at a very significant level.

Week 6 – This marked the end of the teachers month at the Institute, however 15 teachers were given special permission by their schools and the Institute to spend an additional week with me in order to be trained as STEM trainers. The goal is that they will work with their home school staff to introduce the STEM ideas, and also lead a one day Regional STEM seminar one day per month to expand the network of teachers trying out the new ideas. Working in teams of 2 or 3, they each lead a one hour STEM workshop for 25 teachers at the Institute that was observed by their colleagues followed by a group analysis and debrief. The actual 5 hour, full day STEM workshops were scheduled to begin in March 2020 and our concluding activity was designing what a possible training could look like.

At various times through the six weeks and on weekends, Allan also led teacher STEM workshops, typically 60-90 minutes which were a hands-on introduction to STEM teaching methods. Director A'lamjon typically organized these, and he would accompany him to the centers which were a 2 or more hour drive from Samarqand in regional villages. Typically these had 30-40 teachers gathered from the area and took place in Kushrabad, Savagan and Tailik. Allan also traveled to the new Presidential School in Khiva, a trip which he organized on my own with help from International Director Rychard Paszkovski. This was a three day trip since it was an 11 hour, overnight train ride. It was a great opportunity to see first hand this national initiative which eventually will create a Presidential School in each of the 12 Oblasts around Uzbekistan. At this point there are currently 4 Presidential Schools open with the others still in the planning or construction phases.

Allan also led a number of model lessons at area schools so that teachers could see what it means to integrate STEM methodologies and the 8 NGSS Skills. These typically were an hour long for groups of 25-35 students with 10 or more teachers watching. These took place at 6 area schools as well as in Bukhara (School #29) and in Khiva at the Presidential School.

Our learning and next step recommendations:

According to Allan, "these six weeks in Samarqand, UZB were perhaps the most successful professional experience I have ever had, especially in regards to working in the area of teacher professional development. " From all feedback we received, the participants and the Institute for Teacher Certification also feels that it was a very successful experience for everyone involved. It is interesting to note that although we began with a rough template of what the 6 weeks would look like, we definitely made significant adjustments as things moved faster or slower and our learning grew together. That flexibility was, and will continue to be important as this work continues. Just like excellent classroom instruction for student needs to be responsive to their needs, so does professional development for teachers.

Much of the success of our program grew from the advice that Sandra Valazquez provided to the Ministry of Education and the Embassy – moving the program from the Ministry level to be centered at the Teacher Institute for Teacher Certification gave us access to teachers, instructors, kids and schools – and it was this access that made the program much more

impactful and successful. Each of the 12 Oblasts has an Institute, so our first recommendation would be that any work with a new DAST STEM fellow expand to another area, perhaps in the North up at Urgench which has a strong connection with the Embassy through the ACCESS program, or perhaps Bukhara where School #29 is really trying to get STEM online for next fall. There are tremendous possibilities for using the new Presidential Schools as a model for high level technology integration, something that is likely still years away from happening in most UZB General Schools – but building them into part of the program, if well thought out, could really provide for some great learning possibilities – perhaps with Nuxus up in the north?

If a DAST fellow is again placed to work in an Institute for Teacher Certification then if will be important to assure that the Director is in full support of the program and that someone with significant influence (such as the ability to rearrange teacher and staff schedules quickly) is put in charge and works directly with the fellow. Dilbar and Allan met regularly and often made significant changes daily that altered where and when teachers would meet – and with 800 teachers and 65 instructors there were a huge number of scheduling factors to consider. Some of our most difficult days were when Dilbar was not at the Institute owing to some other obligation, as it was found that good intentions don't often lead to good results in UZB as everyone assumes someone else is taking care of things. This level of flexibility and organization requires a ton of work to be done behind the scenes to arrange for model classes in schools or collect 25 teachers for an introduction to STEM lesson – but Dilbar always was able to make it happen or at least communicate what options were realistically available.

Our second recommendation is specifically for the Samarqand Regional Institute, and it is that several areas of follow-up training be developed and planned for implementation as soon as the present coronavirus situation allows. These would include:

- Providing extensive workshop training for Institute Faculty – if this group can gain a deep understanding of STEM and use the approach in their monthly sessions with 25 teachers then we think STEM can quickly grow throughout the Oblast as this would mean as many as 800 teachers every month, or nearly 7000 teachers each year are potentially beginning to use STEM in their lessons. This would quickly grow the impact – much more so than just working with a small group of teachers at the institute as we were able to do with this project. It took over 30 hours of training to move the teachers to the point where they really understood STEM and were ready to use it in their actual lessons so with that in mind this likely is a one or two week training just to give them a basic understanding.
- Continue to grow the skills level and knowledge of the 25 trainers that were part of this project by offering them the next step of training which would really dig into how to plan an instructional unit according to the 5 E's pedagogy model. Right now the focus has really been on single lessons and this would allow them to create sets of lessons design to help students develop the 8 Science and Engineering Practices through instruction. This should come after they have had time to really play with STEM in their classes for a while so that they have some actual experiences, lessons and student work to explore.

Continue to train new groups of teachers to be STEM trainers – this will likely be a group that doesn't know a lot about it so this would likely be a 3 week training, with week 1 being an overview, week 2 being actual practice using STEM with kids, and week looking at how to lead a training. For starters these trainers could then partner with our more experienced trainers so that their learning can continue even while they lead 1 day sessions around the Oblast.

Our third recommendation is that the Institute provide ongoing, embedded professional development to support teachers who have undergone some STEM training and are now trying to implement in their classes (especially this new group of trainers). The most important next step for anyone who has undergone at least a week of STEM training is to have them go back to their school and try to do some implementation. However if there is no follow-up with them, the likelihood of anyone significantly changing their instruction is not very high. We would suggest bringing this group of trainers together – perhaps as often as once a month but at least every two months. The expectation should be that they bring at least 2 lessons that they feel incorporate a STEM approach with them to be shared with the group – including some examples of the work created by the students to demonstrate they can use the 1 or 2 NGSS Skills that were the focus of the lesson. This would provide both accountability, but also allow them to engage with each other, share successes and challenges, and continue to improve. Perhaps this could even be done at a time Samarqand Institute faculty could physically be present to lead / guide the session but also an American STEM expert colleague such as Allan could connect by videoconference and provide some additional training / support. Hopefully there will soon be a group of UZB highly skilled trainers that could lead these for less experienced teachers and perhaps there is a strong STEM teacher at one of the Presidential Schools who could support this work as well?

Our fourth and final recommendation is that the Institute develop a stong program of monthly STEM seminars lead by these new Trainers and Institute Faculty as part of their ongoing Regional Inservice programs at schools throughout the Oblast. Working in teams of 2 or 3, this will be a great way to provide full day training to larger groups of teachers throughout the Oblast once per month, as well as a way to bring the trainers together so that they feel both supported and recognized for their skills. At this point there are not really any Institute Faculty that have been fully trained in STEM so we would suggest that perhaps the group is 2 teacher trainers and 1 Institute Faculty each team. They will need time / support so that they can plan these sessions and have them be a cooperative effort – a lot of their learning will come from the discussions as they plan how best to use the hours and what are the best examples to share with the teachers.

These sessions should provide a broad overview of STEM and then provide some very practical hands-on experience in 2 or 3 of the skills. If they are organized by content area, then it is possible to highlight examples that are particularly relevant to that subject and set of teachers – perhaps modeling, analysis and argument with evidence – these really generalize well to most subject areas. We do offer this suggestion with the caution that it is very important to be patient with these trainers – they are just learning to "ride" the STEM bicycle and as such they

mostly need to be in classrooms learning what STEM looks and feels like as they work with their students. But these workshops can also provide a bit of accountability, in that knowing that they are soon going to be asked to share their STEM learning with colleagues they likely will be even more willing to experiment and collaborate with their fellow trainers to continue to grow their understanding.

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