



The CSI Experience - Incorporating Engaging Curriculum into Middle-School Classrooms across the Country

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Over the past five decades there has been a growing emphasis on active learning in science education¹. In communities around the country there has been a shift from passive learning where students are required to memorize content to an inquiry-based model where students are taught to think for themselves and investigate phenomena through hands-on experimentation in order to develop critical thinking skills. National and state standards have begun to embrace this belief and suggest that students spend a significant amount of time in the classroom learning the methodology of scientific investigations and apply what they learn through projects and experiments^{2,3}. In particular, the Texas state standards for middle school science explicitly state that 40% of student time should be spent conducting experiments⁴. This paradigm shift provides an exciting opportunity for educators and students through the use of innovative and engaging science curriculum that further evolve students' understanding of and curiosity about the world around them⁵.

Outside of conventional classrooms, there is a need to provide students with engaging, informal educational opportunities that reinforce what students learn in school⁶. Learning should not stop just because a student has a few months off for the summer. As a result, successful educational summer programs should instill knowledge and skills in students that can be applied when the students return to school in the fall. In addition to specific science and math content, this also includes the social, communication, and inquiry skills necessary to be a successful scientist such as the ability to work with peers and to communicate effectively⁷. Through the development of skills, summer programs can continue to assist students in their personal and academic growth and may even develop newfound confidence that they can be successful in science⁸.

Program Overview

Building on the framework of inquiry-based learning, in 2010 the Caruth Institute for Engineering Education at Southern Methodist University initiated a Crime Scene Investigation (CSI) Summer Camp program with funding from the Office of Naval Research as a means of providing middle school students with an introduction into the science, technology, engineering and math (STEM) used by experts in crime solving. During each of these week-long events, students participate in hands-on activities and attend presentations by law enforcement officials and forensic scientists. These experts provide real-world applications and introduce students to STEM professions with which they may have otherwise been unfamiliar. Each camp uses an inquiry-based learning approach oriented around a crime scene that students discover the first morning of the program. This framework adds an element of mystery and excitement to the STEM curriculum while instilling confidence in students' abilities in these disciplines.

Program Goals

Although this program is a fun summer camp, the program is engrained in an educational framework that endeavors to provide students with new skills and awareness related to STEM topics. The program emphasizes the development and fostering of critical thinking skills and focuses on teaching students how to think rather than just what to think. Through hands-on activities, we assess students' current knowledge and skills and build upon these through hands-on experience. In addition to hands-on activities, the program allows students to have personal

experiences with professionals who work in STEM-related positions, providing students with real-world context for the content and skills they are learning through the activities.

Through the program we also aim to encourage students to conceptualize real-world issues or questions and facilitate the students' pursuit of possible resolutions or explanations. In doing this, we provide differentiated instruction to accommodate different learning styles and actively engage students through a variety of activities focused on different STEM-related phenomena. In addition to the STEM-focus of the activities, we endeavor to enhance learning in other subjects through highlighting the interdisciplinary nature of STEM and CSI.

Program Structure

The CSI Summer Camps are oriented around a mock crime scene that is discovered the first morning of camp. This mock crime is the basis of the camp and provides the framework for all of the presentations and activities that campers participate in throughout the week. Throughout the camps, the evidence that the campers collect from the crime scene is used in their activities and through their analysis they are able to narrow down a list of suspects consisting of all CSI camp staff members. Through activities such as paper chromatography, face recognition, fingerprint analysis, and DNA electrophoresis campers use a variety of math, science and technology skills to analyze evidence and experience being a crime scene investigator.



Figure 1: Campers from the 2011 CSI-Girls Camp investigate the mock crime scene

In addition to the hands-on activities, campers also hear from real-world CSI experts who provide insight into different aspects of CSI and introduce campers to careers that they may otherwise be unaware exist. In their presentations, each presenter includes a brief overview of their personal background, why they chose their particular career, what they career entails, as well as recommendations for classes or extracurricular activities that students should consider if they want to pursue a similar career. All presentations are engaging and incorporate some degree of student participation and include the opportunity for campers and teachers to ask the presenter questions.

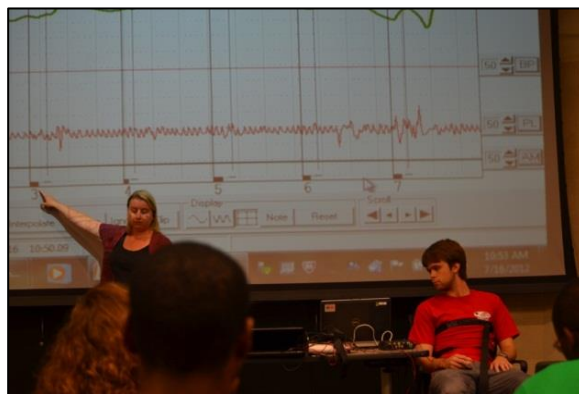


Figure 2: A psychophysiological expert explains one of the mock suspect's polygraph results

During the camps, participants are split into four CSI Units that are denoted by different colored t-shirts. Each unit is led by two teachers and one counselor and includes 15 campers. This structure provides campers with the opportunity to meet peers that they do not go to school with

and otherwise would likely not know. Units are required to work as a team throughout the camp and unit members are encouraged to work together during many of the activities.

Program Participants

Participants in this each camp include 60 campers (middle school students), 16 teachers (middle school teachers) and four counselors (undergraduate and graduate STEM students). Within this program, particular effort has been made to include campers and teachers from underserved and high-need communities. As a result, beginning in 2011 all of the 60 camper slots for each camp have been reserved for students from partner charter schools because of their dedication to underserved students and their focus on academic and personal success.

Students who participate in the camp are limited to rising sixth and seventh grader to ensure that campers are generally on similar academic levels. This enables us to focus the math and science skills emphasized in the curriculum on those skills and content that is most appropriate for this age group. All curriculum is also mapped to local math, science and technology standards, helping to ensure that the content and skills taught during the camp will be beneficial to the campers when they return to school in the Fall. Since 2010, this program has been offered to 306 campers, including 198 girls and 108 boys.

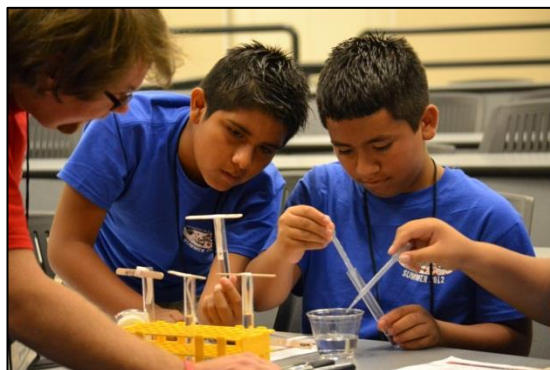


Figure 3: Campers from the 2012 CSI-Boys Camp work together during the Paper Chromatography Lab

As part of the application process, students are asked to complete an application form with standard questions. Application packages are also required to include a picture of the applying student and a 100-word essay explaining why they want to come to the camp. Since 2011 we have worked with partner charter schools to identify the number of students each school would like to send to the camps. As a result, all potential campers who apply through their schools are accepted to participate in the camps. These partnerships allow the schools to select the students that they believe will enjoy or gain the most out of the camp experience. We have found this arrangement to be very beneficial.

Teachers who participate in the camp are generally limited to middle school math and science teachers. Particular attention has been paid to recruiting teachers from the schools that campers attend, however the opportunity to teach at the CSI Camps is open for any teacher to apply for. As part of the application process, teachers are asked to complete a standard application form with personal information including school(s) where they teach, years of teaching experience, classes taught and their educational background. Teachers were also asked to include information about the project-based learning experience, what they hoped to learn from the experience and take back to their classroom and how they thought they could contribute to the camp.

Starting with the 2011 camps, we started inviting Knowledge is Power Program (KIPP) teachers from outside of the Dallas area to participate. KIPP is a national charter school network that is

highly regarded for its impact on students in underserved communities. Only one teacher during the 2011 camps came from outside of the Dallas area, however, during the 2012 camps, nine of the 16 teachers came from out-of-town for the week-long program. In order to facilitate the participation of out-of-town KIPP teachers, we provide all travel and lodging costs for the week. The involvement of teachers from outside of the area further expands the reach of this program.

All teachers for the CSI Summer Camps are required to attend a half-day training session on the Sunday before their camp begins. This training session allows teachers to become familiar with their co-teachers and counselors as well as to gain experience with the camp activities. During the training session, we provide an overview of the camp, give all camp staff a tour of the camp facilities, and run through many of the camp activities to ensure that all teachers and counselors are comfortable with teaching the material and facilitating their units' investigation and analysis of the crime scene and evidence. This session also introduces teachers to the CSI kit that they receive at the end of the week to take back to their schools.



Figure 4: A teacher from the 2012 CSI-Boys Camp assists campers during the DNA Extraction activity

Counselors who participate in the camp are undergraduate students who are either already on our STEM or biometrics teams within our organization or undergraduate students who graduated from a local KIPP school. These counselors serve as near-peer mentors for the campers in their unit and assist teachers with the facilitation of their unit. Counselors often form strong relationships with the campers in their units and provide insights into their backgrounds, what they are studying in school, and what they are working toward accomplishing in their studies. Feedback from campers during each camp shows that Counselors serve an important role in the camp and that having a college-age student share their experiences promotes some camper's interest and confidence in their abilities to pursue higher education.



Figure 5: A counselor from the 2012 CSI-Girls Camp scans a camper's fingerprint for the Fingerprint Sensor activity

Program Impact

Since 2010, this summer camp program has served approximately 300 students, 23 teachers and 20 undergraduate students. The impact of this program is further expanded due to the CSI kits that all teachers return to their schools with. These kits include all curriculum from the camp, a laptop computer, software, a printer, a fingerprint scanner and a rolling case to transport these materials. These materials assist the teachers in replicating many of the camp activities in their classrooms and in their communities. As a result of these kits, approximately 5,100 additional students have been indirectly impacted by the program since 2011.

In addition to the indirect impacts from the CSI kits, many of the activities from the camp have been added to two STEM websites managed by our organization (Kids Ahead at www.KidsAhead.com and STEM-Works at www.STEM-Works.com). Since the beginning of the camps, the CSI camp curriculum has received over 4,500 pageviews and related content in the areas of CSI, forensics and biometrics have received another nearly 150,000 pageviews. The international reach of these two websites and the related content on these sites expands the impact of this program.

Program Evaluation

During the camps, numerous perception and feedback assessments are used to collect the data necessary to evaluate the program. These assessments are grouped into three categories: camper and teacher perception; daily feedback; and teacher follow-up. Upon first arrival at the camp, students complete initial perception assessments regarding their current interests in and perceived importance of science and math. Campers then complete this assessment again at the end of the week. Results from this camper perception assessment have shown that the camps increase student interest in both math and science and also increase the likelihood of these students pursuing advanced education and careers in STEM fields.

Results from the 2012 student perception surveys show that both boy and girl campers like science but girl campers generally like math more than boy campers. Boys are slightly more likely to take advanced science in high school and college and girls are more likely to advanced math in high school and college. Girls generally feel like learning math and science is useful in other classes and areas of their lives. Boys and girls both feel that it is important to learn and earn good grades in math and science.

Both the boys and girls responses increased after the camp for questions related to the likelihood of them taking advanced math and science and pursuing careers in these areas. The girls' responses to the surveys overall increased for all questions except for one in which it dropped only .01 of a point on a 4-point Likert scale. The boys' responses varied from the pre-camp survey to the post-camp survey but generally did not fluctuate more than .15 of a point. For full pre- and post-camp perception survey results see Figure 6.

		Boys		Girls	
		Pre-Camp	Post-Camp	Pre-Camp	Post-Camp
1. How much do you like...	Science	3.47	3.74	3.20	3.59
	Math	2.84	2.80	3.14	3.27
	English/Language Arts	2.84	2.83	2.96	3.08
2. How likely are you to...	Take advanced science in high school	3.09	3.57	3.00	3.41
	Take advanced math in high school	2.86	3.22	2.96	3.43
	Major in science in college	3.00	3.36	2.82	3.35
	Major in math in college	2.65	2.98	2.82	3.30
	Pursue a career in science	2.88	3.02	2.88	3.27
	Pursue a career in math	2.42	2.74	2.68	3.14
3. How important is it to you...	To earn a good grade in science	3.85	3.81	3.80	3.95
	To earn a good grade in math	3.71	3.57	3.82	3.86
	To learn and be good at science	3.80	3.68	3.76	3.86
	To learn and be good at math	3.76	3.72	3.80	3.92
4. How useful is learning math to you for...	Doing well in your other classes	3.46	3.53	3.76	3.89
	Day-to-day living activities	3.24	3.40	3.28	3.64
	Getting a good job	3.80	3.66	3.86	3.97
	Getting into college	3.85	3.81	3.94	4.00
5. How useful is learning science to you for...	Doing well in your other classes	3.41	3.55	3.66	3.75
	Day-to-day living activities	3.39	3.40	3.43	3.47
	Getting a good job	3.68	3.70	3.82	3.89
	Getting into college	3.80	3.72	3.84	3.83

Figure 6: Average camper ratings from pre- and post-camp perception surveys

It is important to note that the increases in campers' ratings related to their interest and likelihood to pursue further education in math and science were quite significant. For the question related to campers' interest in science there was a 0.27 increase in ratings for boys and a 0.39 increase for girls. Other questions with significant increases between pre-camp and post-camp ratings include:

- An increase of 0.48 (boys) and 0.41 (girls) in their likelihood to take advanced science in high school
- An increase of 0.36 (boys) and 0.47 (girls) in their likelihood to take advanced math in high school
- An increase of 0.36 (boys) and 0.53 (girls) in their likelihood to major in science in college
- An increase of 0.36 (boys) and 0.48 (girls) in their likelihood to major in math in college
- An increase of 0.14 (boys) and 0.39 (girls) in their likelihood to pursue a career in science
- An increase of 0.32 (boys) and 0.46 (girls) in their likelihood to pursue a career in math

These ratings demonstrate a noteworthy change in both girl and boy campers' perceptions about and interest in science and math. Additionally, 94% of girl campers and 84% of boy campers from the 2012 summer camp responded that they would like to learn more about CSI.

Teacher perception assessments address classroom teaching methods and how teachers anticipate incorporating the new curriculum into their classrooms. Starting with the 2012 summer camps, teachers are contacted at the end of each semester to complete a follow-up assessment with questions related to their use of the curriculum, suggested modifications or best practices for its use and the number of additional students impacted by the camp materials. A follow-on paper will address these results.

Program Expansion

Due to the positive results received during the first three years executing the summer camps, this program has been expanded to include CSI Camps-for-a-Day and CSI Teacher Trainings and Professional Certification Workshops around the country. Each of these programs further extends the impact of the CSI Camp curriculum and provides diverse communities around the country with the opportunity to engage with this impactful curriculum.

CSI Camp-for-a-Day. Based on the positive feedback we received from participants as well as the interest we received from people outside of the Dallas region, we decided to expand the CSI Summer Camp program. In order to do this we partnered with the Military Child Education Coalition (MCEC) that has strong connections in military communities around the country. To test the camp-for-a-day concept, we hosted a pilot CSI Camp-for-a-Day program for 100 students and six teachers in Killen, Texas outside of Fort Hood in March 2012. Teachers who participated in the event received a mini CSI kit to take back to their classrooms including the CSI camp curriculum as well as a fingerprint scanner.

Following the pilot CSI Camp-for-a-Day, we secured funding from the Office of Naval Research (ONR) to offer eight CSI Camps-for-a-Day in military connected communities. The first of these camps was offered to 98 students and six teachers near Joint Base Lewis-McChord in Washington State and planning has begun for the next two camps to be offered during the spring of 2013. In addition to the one day camp, we are also working with each community to offer a half-day CSI Teacher Workshop for local teachers who are interested in incorporating engaging CSI activities into their classroom curriculum. When possible, we will work with the states where we offer this program to provide professional development hours to teachers who attend the workshop.



Figure 7: A soldier from the Joint Base Lewis-McChord Military Police demonstrates fingerprint dusting to campers during the first CSI Camp-for-a-Day

CSI Teacher Training. In addition to the CSI Camp-for-a-Day, we have also initiated a CSI Teacher Training and Professional Certification program. This ten-hour workshop offers an introduction to the fundamentals of CSI and the science, math and technology used by crime scene investigators. This program greatly expands the reach of the CSI curriculum and increases

the number of students who will be introduced to engaging content that may spur their interest in STEM subjects. To test this concept, we received funding from the Department of Defense to offer a small pilot event during 2012 and a larger event in 2013.

In this program, similar to the CSI Summer Camps, all participant teachers are split into Units where they work as a team and get to know other participants that they may otherwise not know. Each unit is led by a mentor teacher who has served as a teacher during one of the CSI Summer Camps. These mentors are key members of the workshop team and provide insight as to how the curriculum can be implemented, how students respond to particular activities and best practices as well as modifications for the activities.

Throughout the training, participants gain knowledge of how to replicate the hands-on CSI activities within their classrooms. These activities are accompanied by presentations by local law enforcement officials and education professionals, as well as engaging critical discussions on how to implement the CSI curriculum in their classrooms. All teachers who participate in this program receive a mini CSI kit including the full CSI camp curriculum and a fingerprint scanner.



Figure 8: Two teachers work together during the DNA Extraction activity at the 2012 CSI Teacher Workshop

The pilot CSI Teacher Training and Professional Certification program was held in Dallas in August 2012. Twenty-nine teachers participated in this pilot event and 100% of the teachers responded to a post-event survey that they would recommend the event to their colleagues. We are in the very early stages of planning for the 2013 workshop and hope to offer this program to approximately 100 additional teachers.

Conclusion

The CSI Summer Camp program has been very successful at introducing thousands of middle school students to engaging STEM curriculum. Through the expansion of the CSI program to include camps-for-a-day and teacher workshops, this program has the potential to reach and impact hundreds of thousands of kids over the next few years of program implementation and growth. Building on the assessments and feedback from participants at each of these programs, we will continue to evolve the programs and CSI curriculum in order to provide engaging materials and learning experiences for students and teachers.

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