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A Week Long Summer Program Does Make a Difference: A Strategy of Increasing Underrepresented Minority Students' Interest in Science

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The objective of this study was to inspire, engage, and educate minority, underprivileged, low-income middle school students in science. It was a week-long study where students were engaged for 5 hours per day. The content covered was STEM focused embedded with cooperative learning and guided discovery approaches. Students were introduced to the K'NEX Education Amusement Park Experience kit. The students participated in the project theme called "Science of Roller Coaster." Participants were challenged to use their critical thinking skills to design their individual group Roller Coaster project. The constructivist teaching along with positive reinforcement approaches were used during the program, which allowed the classroom facilitator to develop positive learning environment. Pre-and Post-content knowledge tests along with program satisfactory survey, and reflection were collected. Paired t-test results indicated that students score improved on posttest and the difference was statistically significant (p<0.05). Drawing from the students' survey and reflective journal responses, the findings suggest that students who had absolute no interest in science prior to attending the program did increase their interest in science as a result of this program.

Keywords: K'NEX Education, constructivist, positive reinforcement

INTRODUCTION

The Science Technology Engineering and Mathematics (STEM) fields are one of the few areas where there is job growth. According Lacey and Wright (2009) and National Science Board (2010), by 2018, nine of the ten fastest growing occupations that require at least a bachelor's degree will depend on significant math and science training, and may science and engineering occupations are projected to grow faster that the average rate for all occupations . Despite the benefits of pursuing study in these areas, underrepresented minorities (URMs) African Americans, Hispanics, and

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Native Americans represent less than 10% of college graduates working in science and engineering occupations (Sobowale, 2012). Some studies have reported that minorities (nonwhites) were less likely to be successful in higher education (McNairy, 1996; Wohlgemuth, Whalen, Sullivan, Nading, Shelley, & Wang, 2007), especially in science, engineering, and mathematics (SEM) disciplines (Seymour & Hewitt, 1997). Increasing the success of racial and ethnic minority students in science, technology, engineering, and mathematics (STEM) has become a critical issue (Palmer, Maramba, & Gasman, 2012; Nathan & Bolton, 2010; Eisen *et al.* 2005; National Science Board, 2010; Obama, 2010). Indeed, several trends underscore the importance of fostering success among minority students in STEM education. For example, according to U.S. Census Bureau projections, racial and ethnic minorities are expected to comprise more than half of the national population by 2050 (Sobowale, 2012). This demographic shift means that minority students will make up an increasingly larger percentage of students in the national education system and STEM talent pool. Yet, relatively low rates of success among minority students in STEM education persist (Palmer, Maramba, & Gasman, 2012; Nathan & Bolton, 2010; Eisen et al. 2005; National Science Board, 2010). Thus, understanding how to maximize success among racial and ethnic minorities in STEM education is ever more critical (Sobowale, 2012). These differential participation rates in STEM field are particularly detrimental because it causes major impact on underrepresented students' long term social mobility, thus perpetuating socioeconomic inequality (Carter, 2006). Despite these rising alarms, a fair amount of empirical interest, most research focuses on persistence and attainment among students who have already entered STEM fields (Sobowale, 2012). No enough attention has been diverted to increase interest in and inference into STEM fields, especially at elementary level, which more precisely the first critical steps into STEM pipeline (Sobowale, 2012). Early and frequent exposure is essential for students to get interest in STEM areas; therefore treating elementary, secondary, and postsecondary education efforts in isolation would severely hinder the national goal of producing more STEM graduates to meet the nation demand (Sobowale, 2012). The present study assessed short term exposure to STEM areas and how it helped to create a positive impact on students, especially, theirs views towards science.

Why summer program?

A study conducted in early eighties by Eccles, Adler, Futterman, Goff, Kaczala, & Meece (1983) suggested that participants were generally positive and had relatively high mathematics and science motivation. However, population we are serving now is entirely different, we have to use modern intellect which is comprised of art (knowledge and ability) plus craft (technology proficiency) to make this population be interested in science and math, more importantly during summer. There are studies (Freedman, 1997; Parker & Gerber, 2000, Romance & Vitale, 2001; Gerber, Cavallo, & Marek, 2001; Weinberg, Basile, & Albright, 2011) whose findings suggest that summer program which occurs in informal settings does increase students' interest in science and math. Weinberg, Basile, & Albright (2011) additionally, suggest that overall interest in mathematics increased after completing the program evidence suggests the program brought about meaningful change. Stake & Mares (2001) suggests that science experiences which are positive and motivating, where students are engaged and have opportunity to conduct hands-on activities are more likely to gain confidence and positive self-efficacy. This article is mainly about the effect of science enrichment program during a short summer week and its positive implications on students' attitude towards science learning. As recommended by National Council for Educational Statistics [NCES], (2004) and National Science Board [NSB] (2006), it is very essential for middle school students to be exposed to stimulating science education. One of the ways to do so is via exposing these students to short term summer or after school programming in informal settings, where students experience hands-on inquiry based science in non-graded or stressful environment. Learning in such environment are referred as non-academic or "Informal Learning Environment." As indicated by Freedman (1997); Parker & Gerber, (2000), Romance & Vitale, (2001), the informal science enrichment programs are often inquiry-based and aim to emphasize the connections between science and the real world. Studies have suggested that there are positive outcomes as a result of students' exposure to science enrichment programs (Marcowitz, 2004; Redmond, 2000). Longitudinal studies conducted by (Marcowitz, 2004; Redmond, 2000) suggest positive effects of informal learning on self-efficacy and participation in science-related activities or courses, as well as interest in science-related careers (Marcowitz, 2004). Gerber, Cavallo, & Marek, (2001) studies supports that informal learning experiences correspond to higher scientific reasoning abilities. Additionally, informal learning environment also provided greater ability to assimilate and understand formal classroom information (Adey & Shayer, 1990). Jarvis & Pell, (2005); Parker & Gerber, (2000) also indicates that students exposure to voluntary, interest driven learning experiences can increase students' interest in and enthusiasm for science and that perhaps may have long term continued impact on students over time (Rennie, 1994; Wolins, Jensen, & Ulzheimer, 1992).

METHODS

Participants: Voluntary student participants from low-income, minority, high crime neighborhood. **Procedure**: Pre-test was administered on the first day of the program and post-test administered on the last day of the program. Table 1 explains the details of the program content and resources. To assess the program satisfaction of the participants, a survey was administered at the end of the program. To assess if participants learned the content and enjoyed the program, the participants were required to submit the program reflection journal at the end of the program. As an incentive, five dollars gift card was awarded to the student participants who volunteered to participate in the content knowledge pre- and post- tests and the submitted reflection journal. The student participants were given a scan form answer sheet, test questions, and a program satisfaction survey with directions for its completion. The directions explained the study's purpose. The researcher read the directions aloud and explained to the student participants what needed to be filled in on the scan form and the survey. Twenty-five minutes were allocated for student participants to complete pre-test. Upon completion, all the materials were collected. The scan forms were scanned and the resulting raw data files were converted to Excel data files and later exported to SPSS data files. The program satisfaction survey information was manually entered by the researcher in Excel data file and later exported to SPSS data files.

The instruments

Two instruments were used in this study. One of the instruments was content knowledge assessments. These instruments were developed by content experts. During the development stage of these instruments, the content areas to be assessed were identified and cross-validated by course instructors as being reflective of the curricula. The grade-specific content areas are shown in Table 1. The content questions came from seventh and eighth grade that covered the materials addressed in physical science domain. Pre-validated questions were selected in order to eliminate the validity issue involved with creating "internally-designed" achievement tests. Fourteen multiple choice questions were included on the test. All items had four possible answers. Similarly, the second instrument was a program satisfaction survey. The instruments used were field tested for the purposes of this study in regular after school programming in order to conduct the analysis of content validity and seek aberrant responses. After the field test, only minor changes were incorporated, such as answer choice numbering or the deletion of one question as suggested by a current faculty member, and the addition of two student success questions. However, the instruments retained all of the original design elements used in the field-tested version.

Program overview

The study was conducted in the STEM Camp, which started on June 23rd 2012 and ended on June 29th 2012. It was a week long summer STEM camp for entering 7th grades up to entering 8th grade. Three certified teachers along three STEM undergraduate students were provided sixteen hours of STEM contents training. There was a maximum of ten students in each classroom facilitated by one classroom teacher and an aid from the community partners. Students were administered post program surveys at the end of the summer STEM program. The STEM programming was for five days a week, six hours per day. Students were introduced to the K'NEX Education Amusement Park Experience kit. The participants were educated on Newton's three laws of motion and the project they were assigned was the "Science of Amusement Park." They were challenged to use their critical thinking skills to design their group rollercoaster project. The constructivist teaching along with positive reinforcement approaches were used during the program, which allowed the classroom facilitator to develop positive learning environment. Students worked in a group of 3-4 with K'NEX Education Kit.

K'NEX Education Kit

"The K'NEX® Education Amusement Park Experience Set provides an opportunity to combine real-world applications with STEM concepts in a middle school classroom environment. Using these materials, students will be engaged and energized as they experience the interrelationships and further their knowledge and understanding of the science, technology, engineering and math concepts associated with such rides and structures. The Teacher's Guide offers a teaching approach that challenges students to take an active role in constructing their own knowledge by engaging in hands-on, inquiry-based learning, and by interacting and collaborating with other students while discussing ideas and concepts, informs the activities associated with the K'NEX® Education Amusement Park set. Set includes 2264 K'NEX® parts – enough to build 13 K'NEX® Amusement Park Rides, including 2 Roller Coasters. Support 6 - 8 students working as teams. Grades 5 - 9. Building instructions comprehensive teacher's guide aligned to Science, Technology, Engineering and Math Standards included. STEM Education focuses on science, technology, engineering and mathematics concepts taught through problem-solving, discovery, exploratory learning and critical thinking. STEM Education requires students to be active participants in the learning. K'NEX® models offer hands-on learning opportunities that encourage scientific inquiry, investigation and experimentation. Our inquiry-based lessons challenge students as they build, investigate, problem solve, discuss, and evaluate scientific and design principles in action and is also aligned to Science, Technology, Engineering, and Math standards." (Knex's 2012).

The following table shows the breakdown of a weeklong activity:

Table 2. Program satisfaction survey responses

Day	Content	Resources
Monday:	• Newton's Laws • Types of Force • KE and PE • Marble Run 1,2, and 3	NASA Physics of Roller Coaster Guide
Tuesday:	• Continued Energy discussion • Marble Collisions • Foam Rockets • Projectile/Launch Angles	NASA Physics of Roller Coaster Guide
Wednesday:	• Scientific Method • Constructing Rollercoasters • Net Forces • Critical Thinking Skills	NASA Physics of Roller Coaster Guide School (state standard) curriculum
Thursday	• Design Presentations o Engineering o Safety o Physics o History	NASA Physics of Roller Coaster Guide School (state standard) curriculum
Friday	• Design Modification • Scaling • Speed, rate, amount • Presentation	NASA Physics of Roller Coaster Guide School (state standard) curriculum

RESULTS

Table 2. Showing day, content, and resources

STEM Program Outcomes	Agree	Program Goal 25%
I enjoyed the summer STEM Program.	89%	
Summer program increased my interest in Engineering	42%	
Summer program increased my interest in Science	62%	
Summer program increased my interest in Technology	65%	
My participation in this summer program has led to increase interest in science career	57%	
As a result of participation in this program, I'm more confident in doing science and math at my school	63%	
Summer STEM has inspired me to learn more about math and science	64%	
Summer STEM was a good investment of my time	79%	

There were total of twenty-seven participants and seventeen of them completed both pre-and-post tests. Paired t-test was used to analyze the data. The pre-post test results indicated that there was statistically significant difference between pre-post results (N= 17; p = 0.005). Pre-test average score was 4.29 and post-test average score was 7.71. **Program Satisfaction Survey**: A subset of summer participants (62%) completed a survey regarding program satisfaction. As can be seen in the following, students reported that the program helped them in many ways (i.e., like the program, increase interest in science, increase interest in science career, inspired them to learn more about Math and Science). Our program goal was to get at least get 25% positive response. Response to this survey is presented in Table 2.

Student participants' responses regarding the program:

> Here I have learned Newton's 3 laws because before I have really never knew them but I have heard of them. Newton's 3 laws are useful in a lot of different things, but mostly in science. His first law is: An object at rest stays at rest and an object in motion tends to stay in motion unless acted upon by an unbalanced force. This means if something is still or moving it will stay that way unless something makes it act differently. All objects have inertia. Inertia is, a property of matter by which it continues in its existing state of rest or uniform motion in a straight line, unless that state is changed by an external force. Newton's 2nd law is: Force equals mass times acceleration. F=MA; F-force M-mass A-acceleration. Acceleration is a measurement of how quickly an object is changing speed. This formula is used to find the force in an object, and all you have to find is the weight and how fast it is going. Newton's last law is: For every action there is an equal and opposite reaction. *I personally am not a huge science fan anyway, but I had a good time here. I feel like I learned things I didn't know about, and I feel I will be able to put it to good use in the future, especially since science is the subject I struggle with. But I feel like it will help me to become better in science.* **(8th grade participant).**
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> This week at the camp, we learned many things. All of the things we learned related to the same topic. That topic was the physics behind roller coasters. We took notes on different concepts that we needed to know in order to do all of the activities we did. For example, we took notes on Newton's second law: force equals mass times acceleration. Then we did some practice problems regarding how to calculate force, followed by an activity about force using marbles. Afterwards, we worked on our coasters. After they were built, we made PowerPoints using our notes and information we found on the internet. *We learned that wooden coasters cannot have loops; Russians built the first coaster in the 1700s. We also learned that the first hill on a roller coaster gives the car on it the momentum needed to finish the ride. We also learned important terms like inertia, force, and velocity."* **(8th grade Participant).**
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> "I learned many things at the Science camp. One thing I learned is that an object in motion tends to stay in motion, unless acted upon by an external force. That is one of Isaac Newton's 3 laws. *We learned about calculating net force. This is done by factoring in gravity friction and other actions happening to the object to find net force.* We learned how roller coasters use physics a lot when they work. We learned things such as how the cart has to have enough momentum to go through a loop. We also found out how to construct roller coasters using what we had learned. Another thing we learned about roller coaster physics is that the first hill must be bigger than the second to gain the energy for momentum so that way it will go over the hill." **(8th grade Participant).**

"This summer I participated in the science camp that lasted for only a week. When my mother signed me up for it and she told what it was about I really wasn't looking forward to coming. When I got to the classes I realized that this week was going to be really fun. The first day my memory was refreshed about Newton's 3 laws. We also learned about kinetic and potential energy. I met some people that I really enjoyed working with for the week. We built rockets and tested how far the rocket went from a certain launch angle. We also built roller coasters out of foam and tested a marble down the coaster. Learning about the roller coasters was really interesting because I love roller coasters. We built two plastic models of roller coasters from the box. It turned out to be really nice. Our class was really laid back so the teachers let us listen to music while we were working to keep us focused. I learned about roller coaster safety and how kinetic and potential energy is used when it comes to roller coasters. The roller coasters start off with potential energy which leads to kinetic energy. Kinetic energy is used all throughout the ride until it is over. I learned that having hills is very important in a roller coaster. Without the first hill the ride couldn't start off with the energy it needs to get through the ride. The second hill is so the kinetic energy can be kept throughout the ride. I learned the differences between wooden and steel roller coasters. Wooden roller coasters are shaky, they have no loops, and the hills are not very high. Steel roller coasters are high and have lots of hills and loops. *This program was really fun and I enjoyed myself all week. Presenting our PowerPoints about roller coasters was the most fun. We got a chance to show our teachers everything that we learned and how much we enjoyed making everything. If I could come back then I would come back. This was a great experience."* **(8th grade participant)**.

"This week I've learned a lot. I learned how to build a roller coaster and many more things. The first day my memory got refreshed about kinetic energy and Newton's three laws. I actually understand kinetic energy a little more. We took notes and built rockets. Then after we built the rockets we went outside and test how far they would go at an angle. I've learned how to build a roller coaster using Newton's three laws of motion. I thought that that was a very educational way to have fun and enjoy ourselves. But it was a lot of hard work. *I would love to have done it again but we only had five days sadly. During my time at this camp I've had a great experience. I would love to do it again. Hopefully I can come next summer."* **(8th grade participant)**.

I learned about roller coasters and the science and history of roller coasters. I learned that gravity is the reason people get the feeling they get on a roller coaster. The reason people do is because the gravity of the earth is trying to pull you back down. *I learned that at the summit of the 1st hill on a roller coaster there is the greatest amount of gravitational potential energy. I also learned that if a roller coaster has low potential energy it has high kinetic.* **(8th grade participant).**

"Roller coasters were 1st made in Russia. They were 1st being made in the 14 and 15 hundreds. They had frozen tracks and when roller coasters arrived in France in the 1800 they had to change the tracks. They had to because it was milder. Sometimes the carriages fell of the track. *I learned some other things and I think this will help me in high school."* **(8th grade participant).**

"This week I learned what the Laws of Newton are: Newton's First Law was a body remains at rest or in motion with a constant velocity unless it is acted upon by an external force. Then we learned what the Second Law of Newton was. It's the relationship between an object's mass *m,* its acceleration *a,* and the applied force *F* is *F=ma.* Acceleration and Force are vectors and are in the same direction in this law. The last law was for every action there is an equal and opposite reaction." **(8th grade participant)**.

"This week we even learned how to build rockets and roller coasters. We built the rockets with foam tubes then we launched them with meter sticks at different angles. The first roller coaster we made was made out of foam pipes and marbles went down them. The other roller coasters were made out of K'nex it took two days to make it. When were done with one roller coaster we made a Ferris wheel. *I even learned about the diamondback at Kings Island. This is what I did all this week." (I had fun).*" **(8th grade participant)**

"This week I've learned a lot more. I have learned how to make a roller coaster and how they work. I know more than I did before I came here. At first I didn't like it but I liked it at the end. I know more about kinetic and potential energy. I know that if it is moving it is kinetic energy if not moving potential. I also know the 3 newton laws know and I didn't know them at all. This program was kind of interesting after all. It was really fun building the roller coasters and Ferris wheel. From this experience I made new friends and I learn interesting things. At this program I learned a lot of things. I learned about the physics and history of roller coasters. We learned about many different items like the differences between potential and kinetic energy. Potential is stored energy while kinetic energy is energy that is moving. We learned about how speed, velocity, inertia, Newton's three laws, centripetal force and many other things are so important to build a thrilling and safe roller coaster. For the program, we also learned about building many things like roller coasters, rockets, and Ferris wheels. We learned that the angle that you launch a rocket changes the distance and the height. 45 degrees would be the best if you wanted a combination of distance and height. *Not everything was about science though. I learned things that will help me later in life."***(8th grade participant).**

DISCUSSION

Results from this study indicate that science enrichment activity in informal settings does increase students interest in science as supported by similar studies (Freedman, 1997; Parker & Gerber, 2000, Romance & Vitale, 2001; Gerber, Cavallo, & Marek, 2001; Weinberg, Basile, & Albright, 2011 It inspires, engages, and educates minority, underprivileged, low-income students in science. As indicated in literature, minority students are less likely to pursue STEM education in formal settings however, this population can perform well given the modified environment. The participants participated in the project theme called "Science of Roller Coaster." Participants were challenged to use their critical thinking skills to design their individual group Roller Coaster project. The constructivist teaching along with operant conditioning approaches were used during the program, which allowed the classroom facilitator to develop positive learning environment. Pre-and Post-content knowledge tests along with program satisfactory survey and reflection were collected. Paired t-test results indicated that students score improved on posttest and the result was statistically significant. Drawing from the students' survey and reflective journal responses, the findings suggest that students who had absolute no interest in science prior to attending the program did increase their interest in science as a result of this program.

CONCLUSIONS

The objective of this study was to inspire, engage, and educate minority, underprivileged, low-income middle school students in science. Pre-and Post-content knowledge tests along with program satisfactory survey, and reflection were collected. Paired t-test results indicated that students score improved on posttest and the difference was statistically significant. Drawing from the students' survey and reflective journal responses, the findings suggest that students who had absolute no interest in science prior to attending the program did increase their interest in science as a result of this program.

REFERENCES

Adey, P., & Shayer, M. (1990). Accelerating the development of formal thinking in middle and high school students. *Journal of Research in Science Teaching*, 27, 267–285.

Carter, D. F. (2006). Key issues in the persistence of underrepresented minority students. *New Directions for Institutional Research,* 130, 33-46.

Freedman, M. (1997). Relationship among laboratory instruction, attitude toward science, and achievement in science knowledge. *Journal of Research in Science Teaching*, 34(4), 343–357.

Gerber, B., Cavallo, A., & Marek, A., (2001). Relationships among informal learning environments, teaching procedures and scientific reasoning ability. *International Journal of Science Education,* 23(5), 535–549.

Jarvis, T., Pell, A. (2005). Factors influencing elementary school children's attitudes toward science before, during, and after a visit to the UK National Space Centre. *Journal of Research in Science Teaching,* 42(1), 53–83.

Knex's (2012). http://www.knex.com/shop/16789/amusement-park-experience/ retrieved on Jan 26th 2012.

Lacey, T. A. & Wright, B. (2009). Occupational employment project to 2018. *Monthly Labor Review,* 132 (11), 82-123.

Markowitz, D. G. (2004). Evaluation of the long-term impact of a university high school summer science program on students' interest and perceived abilities in science. *Journal of Science Education and Technology,* 13(3), 395–407.

National Council for Educational Statistics (NCES). (2004). Highlights from the trends in international mathematics and science study (TIMSS) 2003. Washington, DC: U.S. Department of Education.

National Science Board (2010). *Preparing the next generation of STEM innovators: Identifying and developing our nation's human capital*. Arlington, VA: Author.

National Science Board (NSB). (2006). Science and engineering indicators 2006 (NSF Publication No. NSB 06-01B). Washington, DC: U.S. Government Printing.

Palmer, R. T., Maramba, D. C., & Gasman, M. (Eds.). (2012). *Fostering success of ethnic and racial minorities in STEM: The role of minority serving institutions*. New York: Routledge.

Parker, V., & Gerber, B. (2000). Effects of a science intervention program on middle-grade student achievement and attitudes. *School Science and Mathematics*, 100(5), 236–242.

Rennie, L. J. (1994). Measuring affective outcomes from a visit to a science education center. *Research in Science Education*, 24, 261–269.

Romance, N. R., & Vitale, M.R. (2001). Implementing an in-depth expanded science model in elementary schools: Multi-year findings, research issues, and policy implications. International *Journal of Science Education,* 23(4), 373–404.

Seymour, E., & Hewitt, N. M. (1997). *Talking about leaving: Why undergraduates leave the sciences*. Boulder, CO: Westview Press.

Sobowale, K. (2012). The Lack of Underrepresented Minorities in STEM Education. Retrieved On June, 9th 2013 from http://www.Kevinmd.Com/Blog/2012/01/Lack-Underrepresented-Minorities-Stem.Html.

Stake, J. E., & Mares, K. R. (2001). Science enrichment programs for gifted high school girls and boys: Predictors of program impact on science confidence and motivation. *Journal of Research on Science Teaching*, 10, 1065–1088.

Weinberg, A. E., Basile, C. G. & Albright, L.(2011). The Effect of an Experiential Learning Program on Middle School Students' Motivation Toward Mathematics and Science, *Research in Middle Level Education,* 35, 3, 1-12.

Wolins, I. S., Jensen, N., & Ulzheimer, R. (1992). Children's memories of museum field trips: A qualitative study. *Journal of Museum Education*, 17, 17–27.

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