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Paper ID #14745

WORK IN PROGRESS: K8—The Future of Engineering Entrepreneurship

Mr. Mike Thomas Pitcher, University of Texas - El Paso

Mike Pitcher is the Director of Academic Technologies at the University of Texas at El Paso. He has had experience in learning in both a traditional university program as well as the new online learning model, which he utilizes in his current position consulting with faculty about the design of new learning experiences. His experience in technology and teaching started in 1993 as a student lab technician and has continued to expand and grow over the years, both technically as well as pedagogically. Currently he works in one of the most technically outstanding buildings in the region where he provides support to students, faculty, and staff in implementing technology inside and outside the classroom, researching new engineering education strategies as well as the technologies to support the 21st century classroom (online and face to face). He also has assisted both the campus as well as the local community in developing technology programs that highlight student skills development in ways that engage and attract individuals towards STEAM and STEM fields by showcasing how those skills impact the current project in real-world ways that people can understand and be involved in. As part of a university that is focused on supporting the 21st century student demographic he continues to innovate and research on how we can design new methods of learning to educate both our students and communities on how STEM and STEAM make up a large part of that vision and our future.

Mr. Pedro Arturo Espinoza, University of Texas - El Paso

Pedro worked in the manufacturing industry as a Quality Control Engineer for some years before acquiring his current position as an Instructional Technologist at the University of Texas at El Paso (UTEP). For over ten years in this role, he has worked with a team of managers that oversee various learning environments and systems in the Academic Technologies Department at UTEP. He leads a group of more than 40 multidisciplinary student employees that help support a wide range of technologies for classrooms and other learning spaces, including videoconferencing rooms. In addition to teaching a Foundations of Engineering course, Pedro also provides technology training on Mac OS X, CISCO networking and various other technology topics. He also enjoys the role of social media coordinator for Academic Technologies to showcase the department's services and the dedicated students and staff members who work there. Pedro received his Bachelor of Science degree in Electrical Engineering and a Master of Science in Engineering with a concentration in Engineering Education from UTEP.

Mr. Hugo Gomez, University of Texas - El Paso

Mr. Hugo Gomez works as an Instructional Technologist at the University of Texas at El Paso, he is focused on expanding the professional and technical skill sets of our students and faculty community to better prepare them for the world of technology today and tomorrow. He works alongside a wide assortment of students, faculty and staff on campus to make sure their technology toolsets are up to date. Furthermore, Hugo provides workshops to over half of the student population at UTEP and as such, has been instrumental in providing the behind the scenes support to all these courses. Mr. Gomez also collaborates in the Learning Lab team to explore and implement new educational strategies in the classroom. Mr. Gomez has a Masters Degree in Engineering Education from The University of Texas at El Paso. He has participated in the UTEACH summer program as a Technology Instructor in which he provided workshops on website design, movie creation and computer networking. In addition, Mr. Gomez teaches UNIV1301 Foundations of Engineering, were students learn academic, personal and engineering skills, among many other abilities that help them understand their opportunities and responsibilities as engineering students.

Mr. Randy Hazael Anaya, University of Texas - El Paso

Randy Anaya, Instructional Technologist at the University of Texas at El Paso. Received a BFA in Graphic Design with a minor in Multimedia design from the Universidad Autónoma de Ciudad Juarez, Mexico. Received a BA in Media Advertising at UTEP and is currently enrolled as a Master of Interdisciplinary

Studies with an emphasis on the use of art and technology in teaching and learning. Randy works on research and development of applying the creative process to workshops, trainings and student engagement. Currently doing extensive research and deployment of emerging technologies to redefine the classroom, mentoring and excellence through student interaction.

Hector Erick Lugo Nevarez, University of Texas - El Paso

Mr. Hector Lugo works as a Student Technology Success Coordinator at The University of Texas at El Paso. He holds a B.S. in Electrical Engineering. He is currently enrolled as a Master of Science with a Major in Electrical Engineering. His motivation and passion pushes him into research in wireless communication, especially in Bluetooth Low Energy and Near Field Communication as well as building projects and fostering innovation with faculty and staff members. As part of the Learning Environments division, the idea to develop, oversee and assess engaging students to expand their knowledge and creativity by innovating new technologies application for Engineering Education is currently under way to engage the university and the community. Concluding, Mr. Lugo's ambition is to encourage students to focus in science, technology and engineer abilities in order to expand their professional potential.

Mrs. Herminia Hemmitt, University of Texas - El Paso

Mrs. Herminia Hemmitt is part of the Learning Environments team in Academic Technologies at The University of Texas at El Paso. She is responsible for coordinating classroom technology upgrades and implementations to ensure project deadlines and anticipated goals are met. Her educational background in organizational and corporate communication is utilized in consultations with faculty and staff about their learning environments in order to correctly match them to appropriate learning spaces or adapt existing spaces to meet their pedagogical and technological needs. Her focus is on the specific user to make sure that classroom needs, technical needs, and/or event needs are met.

Dr. Peter Golding, University of Texas - El Paso

Professor in the Department of Engineering and Leadership at UTEP.

Prof. Oscar Antonio Perez, University of Texas - El Paso

Prof. Oscar Perez received his B.S. and Masters in Electrical Engineering from the University of Texas at El Paso with a special focus on data communications. Awarded the Woody Everett award from the American Society for engineering education August 2011 for the research on the impact of mobile devices in the classroom. He is currently pursuing a PhD in Electrical and Computer Engineering. Prof. Perez has been teaching the Basic Engineering (BE) – BE 1301 course for over 8 years. Lead the design for the development of the new Basic Engineering course (now UNIV 1301) for engineering at UTEP: Engineering, Science and University Colleges. Developed over 5 new courses, including UTEP technology & society core curriculum classes specifically for incoming freshman with a STEM background. Prof. Perez was awarded the 2014 "University of Texas at El Paso award for Outstanding Teaching". Prof. Perez has over thirteen years of professional experience working as an Electrical and Computer Engineer providing technical support to faculty and students utilizing UGLC classrooms and auditoriums. Mr. Perez is committed to the highest level of service to provide an exceptional experience to all of the UGLC guests. Mr. Perez strongly believes that by providing exceptional customer service that UGLC patrons will return to make use of the various services the university offers. Mr. Perez enjoys working on the professional development of the students' employees at the UGLC. He shares with his student employees his practical experience in using electrical engineering concepts and computer technologies to help in everyday real-world applications. Mr. Perez has worked with the UTeach program at UTEP since its creation to streamline the transition process for engineering students from local area high schools to college by equipping their teachers with teaching strategies and technologies each summer. Oscar enjoys teamwork, believes in education as a process for achieving life-long learning rather than as a purely academic pursuit. He currently works on maintaining, upgrading and designing the classroom of the future. Mr. Perez is inspired because he enjoys working with people and technology in the same environment.

WORK IN PROGRESS: K8 - THE FUTURE OF ENGINEERING ENTREPRENEURSHIP

Abstract

Did you ever build a lemonade stand as a child? Most of us will answer yes or can think of a similar entrepreneurial activity we participated in as a child. The real question though is, how many of those entrepreneurial memories happened outside the bounds of school? This paper explores how, in a goal to create the entrepreneurs of tomorrow, the traditional focus is on creating structures to support the high school to college age students. However, it is equally important to lay some great foundations in the kindergarten through 8th grade levels, where one can find an environment ripe to learn, create, and try new ideas.

This paper will discuss how Tech-E camp exposed K-8 kids to a range of challenges that are inherent in entrepreneurship and engineering through a strategy called learning blocks and how these seem to pair well with the push for deeper learning models.

We will look at student and parent assessment of the process and look at future efforts to continue to develop these kids into tomorrow's engineering entrepreneurs. First year outcomes of the project will be shared along with how strategies applied at camp could easily be integrated into a K-8 curriculum lacking dedicated direction to develop essential entrepreneur mindsets.

Introduction

In this paper we discuss the concept of learning blocks as a means to bring entrepreneurial concepts and deeper learning into play within a K-8 STEAM (Science, Technology, Engineering, Arts, and Math) camp along with the ability to expand it into the K-8 curriculum. We take a look at the learning strategies that were utilized in the design of these and how building a camp with learning blocks creates a totally immersive and engaging environment for the learner. At the same time, these learning blocks allow for entrepreneurial concepts to be embedded inherently. The character traits of successful entrepreneurs, as defined by state school standards, are adaptability, creative thinking, ethical behavior, leadership, positive attitude, and risk-taking.[1] These character traits will also be focused on in terms of outcomes.

Materials and methods

Entrepreneurship and deeper learning outcomes have been a recent focus of industry and education with many new studies outlining how these skill sets can substantially change the outcomes of students. Research findings demonstrate improved student outcomes, higher levels of academic engagement, motivation to learn, self-efficacy, and collaboration skills. In addition, students have higher state standardized assessment scores regardless of student background.[2,3,4,5,6,7] The important thing to note is that the key mastery of concepts remains the same, however the learning process and how

students demonstrate their understanding changes and this opens up possibilities to embed in entrepreneurship at a core level.

The National Research Council identified the following research-based methods for developing deeper learning: 1) use multiple and varied representations of concepts and tasks, 2) encourage elaboration, questioning, and self-explanation, 3) engage learners in challenging tasks, with supportive guidance and feedback, 4) teach with examples and cases, 5) prime student motivation and use formative assessment.[8] Learning blocks were created, refined, and utilized in our two most recent Tech-E camps to see if they could maintain the same level of engagement with learners while involving deeper learning and entrepreneurship concepts in them.

Learning blocks were designed to take advantage of key strategies found in project-based learning, such as, tackling realistic problems using the learner's knowledge, increasing learners control over their learning, involving instructors that serve as coaches/facilitators of inquiry and reflection, and utilizing either pairs or groups in the process. [9,10] The challenge portions of the blocks introduce some key entrepreneurship components, which help develop entrepreneurial thinking. The table below outlines the specific sub section of a Tech-E camp learning block which includes an entrepreneurial strategy; following that is an entire outline of a complete learning block.

Sub section of a learning block (where we embedded entrepreneurial strategies)

Do-It **Challenge-It**	A fully hands-on build it, play with it, design it, re-design it section. At least 40 minutes of each block are focused on working with the content within that block in a totally immersive experience. From building a basic computer network from scratch to designing an electrical circuit, a production movie, or a 3D printed object. This section of each block is focused on actually doing something and not just sitting in a chair listening to something. Campers will spend the majority of time in the camp in "Do-It" sections of learning blocks. Some learning blocks have a "Challenge-It" component where campers are presented with a challenge they must overcome to expand the "Do-It" sections by using creative, innovation, or imaginative solutions to common everyday problems.

CONTENTS OF A LEARNING BLOCK	
Jobs/Career/Major	A look at what a job, career, major does and how it applies to this block. What fields, majors, jobs make use of the concepts within this block.
Learn-It	A quick introduction to the concepts, words, theory, ideas that are related to what we are doing in this block. For example how does a basic electrical circuit work, how does a computer work, what does "The Cloud" actually do and how does it work.
Do-It **Challenge-It**	A fully hands-on build it, play with it, design it, re-design it section. At least 40 minutes of each block are focused on working with the content within that block in a totally immersive experience. From building a basic computer network from scratch to designing an electrical circuit, a production movie, or a 3D printed object. This section of each block is focused on actually doing something and not just sitting in a chair listening to something. Campers will spend the majority of time in the camp in "Do-It" sections of learning blocks. Some learning blocks have a "Challenge-It" component where campers are presented with a challenge they must overcome to expand the "Do-It" sections by using creative, innovation, or imaginative solutions to common everyday problems.
Reflect and Think About It	At the end of each block(s) campers will reflect and think about what they learned; how they could use it in everyday life; and if the topic is something that they might want to do in the real-world later on.

For the purposes of this paper we will not focus on the design of the entire block itself but instead on how the Do-It/Challenge-It section allows for opportunities to embed entrepreneurship components within it.

The camp had a total of 36 students ranging in grade level from kindergarten to 8th grade. The challenge sections started with easily defined challenges and scaled substantially in terms of open-ended questions with no direct solutions presented or even hints towards a "correct" solution beyond utilizing resources at hand to develop something to solve the problem or create a product. Again, for brevity, we will take a look at a representative sample of challenge sections from two different blocks. The first is a level 1 challenge or beginning challenge asking students to utilize provided resources to build a product. The second challenge listed from a different block is a level 5 challenge asking kids to not only build a product, but to design both a marketing strategy and a commercial to sell that product to others.

Sample of Learning Block Challenges

Electron Flux Challenge Set (for example purposes listing only 1 challenge level not all):

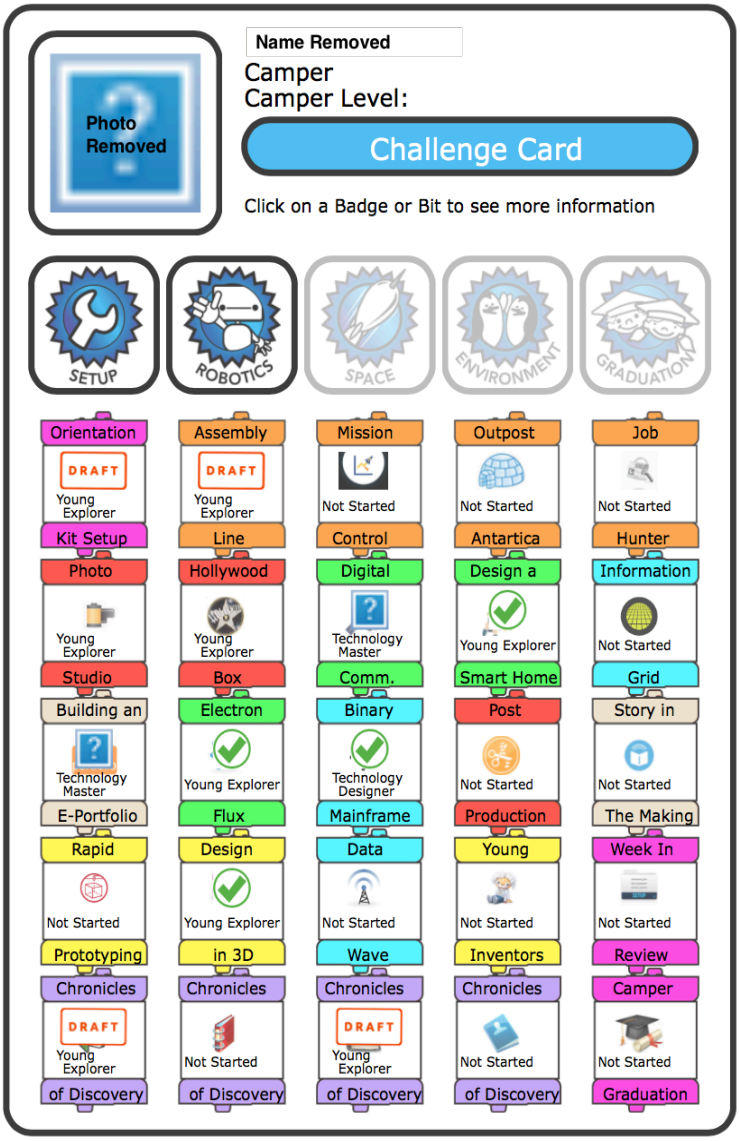
Level 1 - Build a robotic character (animatronic) that moves and talks

Smart Home Challenge Set (for example purposes listing only 1 challenge level not all):

Level 5 - Pick an enchanted object from a movie, storybook, or fable. Write down what the enchanted object does in the story. Write down how those features would be useful in real life. How can you create a real world object that has those same functions using technology, computer science, and engineering? Using the tools that you have available to you such as the litteBits, Legos, paper, markers, etc try to create a prototype or your own working version of this enchanted object so that you can demonstrate how such works to people. Once you have done such create a video telling people what your object does and why they should buy it.

In the Challenge-It section of learning blocks, learners were specifically asked to solve a real world challenge utilizing the resources they had on hand in new and creative ways. They then had to "sell" the solution to the camp instructors as a viable solution to the problem at hand. While there was no physical money or resources at stake, their ability to advance on to the next Challenge-It section revolved solely around their ability to solve the present challenge in a meaningful way and sell their solution as "the answer" to the problem. Camp instructors had a more formative assessment approach at the check-in phases for each challenge in which student teams would not only have to showcase their solution but also explain the how, why, and what of their project. Also, certain terms related to that particular assignment were checked for comprehension and mastery of content before being able to proceed forward to the next challenge. Furthermore, a draft phase for each block was created to allow camp staff to provide guidance to specific teams or individuals struggling with a concept. Many times this turned into additional individualized teachable moments as students wanted to further their understanding to accomplish something of greater scale for their given design idea. Such feedback is the central function of formative assessment and it typically involves a focus on the detailed content of what is being learned, [11] rather than a simple a test score or other measurement of how far a student is falling short of the expected standard.[12]

To allow parents to track the progress of their campers at a distance, a first attempt was made to create an online Challenge Card system. An example screenshot of the tool can be seen below:



Parents and students were surveyed after the camp to assess their level of engagement with the learning blocks model, how engaging the sessions were and their overall progress. Student learning and mastery of skills was assessed via a formative approach at each challenge completion check-in through a final design. Students were required to document their progress via a journaling system through a combination of blogs, posts, photos, and videos. [11,12]

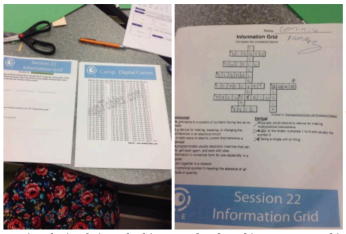
Results

At the end of Tech-E camp we had received a total of 34 e-journals which consisted of 894 journal postings, 1,734 photos, and 440 videos. These ranged from students documenting how a process worked so someone could recreate their design to actual movie trailers, marketing ads, and short films. Below are a few sample postings (please note pictures of students themselves have been cropped out), however, these do not really express the breadth and depth of the content. Most of these are student videos that

describe entire processes or end products which can not be fully expressed in just a snapshot picture of the video.

July 10, 2015

BINARY CODE



Today we worked on turning decimals into the binary code I found it very easy and interesting. Now we are all part of the 50% that knows how to work the code. Two symbols are used in the binary code they are (10). Next we worked on a crossword puzzle that had to do with words that we have been learning today.

June 25, 2015

3D HOUSE

This is the house I designed with a 3D designing site

June 24, 2015

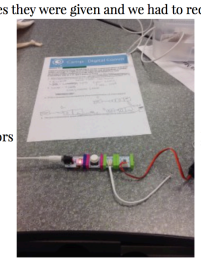
YAY!! WE FINISHED OUR MISSION!!!😌👏 😀👍 😜✌

Our mission was to reassemble a mainframe that was hit by a meteorite (well not really…) and guess what! I was the team leader!! 😇😁 and I have to say we did a great job! I took a bunch of pictures and videos and we had fun!! 😎😋😉😇😇😇

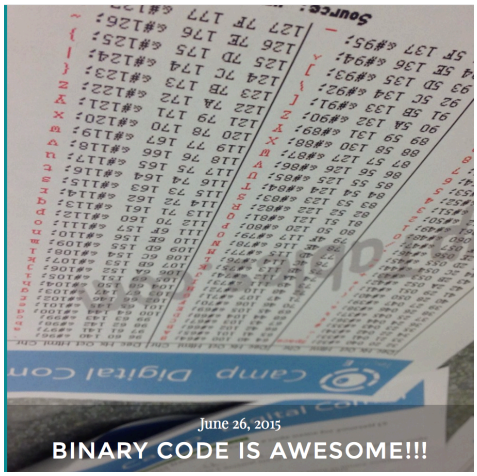
July 8, 2015

COMMUNICATING THROUGH SYMBOLS

Today we used symbols to send a message to another team. They had to find the message with the clues they were given and we had to redo it in a way that was easier and less prone to errors



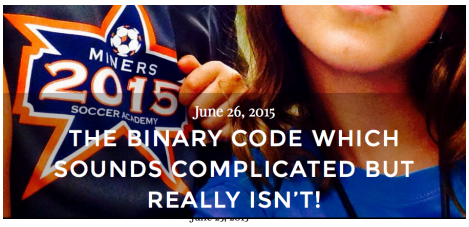
Message



June 24, 2015

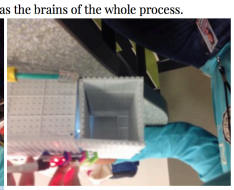
COMPUTERS

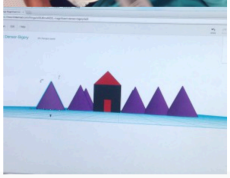
I am building a communication device with the whole group. I hope it works… I am having a lot of fun. Hi mom!!!



DESIGNING A SMART HOME

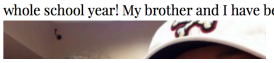
I got to design my own smart home!!! I was the brains of the whole process.





BEST SUMMER EVER!!!

This week has been great so far. I think I already learned more in these two days than a whole school year! My brother and I have been enjoying this great opportunity.



Today i I made a movie trailer about my Yoda that I have mentioned before and I also included my friend's kirby

June 26, 2015

MOVIES STARRING YODA AND KIRBY

IMG_0156 in this video you will see an action movie that is a fairy tale

June 24, 2015

DAY THREE

today we learned about basic computer parts. Then, we put together a computer. My group was the first one to finish. And guess what?! It turned on. Here is a picture of me

"The World Economic Forum defines entrepreneurship as a process that results in creativity, innovation and growth. Innovative entrepreneurs come in all shapes and

forms; its benefits are not limited to startups, innovative ventures and new jobs. Entrepreneurship refers to an individual's ability to turn ideas into action and is therefore a key competence for all, helping young people to be more creative and self-confident in whatever they undertake."[18] From the example screenshots above we can see the wide range of ideas to actions that students created during camp. It is important to note that this all happened while the students were still demonstrating the normal key understanding pieces we would expect at camp in regards to learning terminology and keywords, applying basic concepts, etc. The Do-It/Challenge-It piece allowed for a different approach to teaching and learning. Rather than giving students a typical multiple choice, fill-in the blank or short answer type of assessment, we really made them apply concepts to something tangible and think the process through in much greater depth.

The results from parent feedback about how camp impacted their kids was a bit shocking. We had all 34 surveys returned by parents out of the 34 sent, which translates to an astonishing 100% reply rate. The end of camp survey for parents consisted of the following questions

1) What was the best part of the camp experience?
2) What was the worst part of the camp experience?
3) Do you think your child benefited from camp? YES NO
   Can you tell us specifically in what areas and/or provide details?
4) What could we do to improve camp either specifically or overall?

One third of camp parents stated that camp activities took away campers' anxiety towards science, taking risks, and developing projects on their own or within a team. One parent described it specifically as "instilling confidence and bravery to keep up with others and actually trying to outpace them". Another stated that it "took away anxiety about sciences." A parent described that the child benefited by "My son being excited about learning finally which doesn't happen at school.".

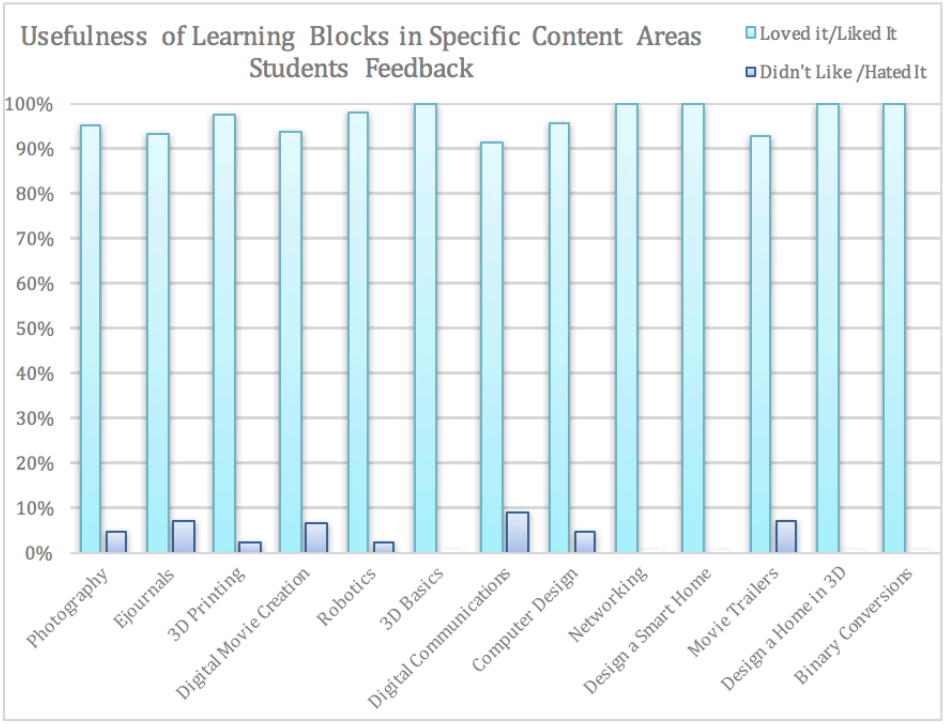
A second strong theme that emerged from parent feedback forms was instilling a technological creativity in their kids. More than two thirds of parents said their kids were exploring and having conversations at home about how technology could be used to solve problems in new ways. Specific examples of parent comments grouped into this area were "She was talking about technology in general and how to use it at our house in new ways", "He was asking questions about how could robots be used at home to fix that problem", "He is using his ideas and what he learned to create new stuff all the time now". What makes this feedback specifically so rewarding to us is that we merely asked an open-ended question about what the child got out of camp. There was no directed question about confidence or bravery, distilling fears, or even about creating and using new ideas, or having discussions about how technologies could impact their everyday lives. Additional responses not grouped directly into the above categories were:

Learning to work with others even if there were also different ages
Exposure to engineering concepts -- He was so excited about the 3D printers and learning more. It gave him more ideas of what possibilities are available in the future.
More observant on following orders

They were allowed to be creative.
En usar computadores y aprender todo lo que puenden hacer y como funciona todo. Tambien aprendieron a ser creativos y destreza con sus manos.
I loved that they had to work together and were able to use their ideas to create.
They were exposed to many areas of technology.
Confidence, technical skills increased

Next we looked at the survey portion that relates to parents' opinion of what could be improved and the worst part of camp. Out of 26 responses to the question of what was the worst part of camp (8 responses were either left blank or answered "nothing"), 12 specifically dealt with length of camp in that the camp was too short (one week). The remaining 14 answers specially wanted more camp dates, a second camp, more publicity about it or additional age ranges/groupings; 1 out of the 14 was geared specifically to providing different snack/food options. However, none of the responses were geared towards content or learning block format issues.

When we asked the campers specifically in regards to their affinity towards learning blocks as opposed to other methods, the results were as follows:



Discussion

The results of utilizing the concept of learning blocks, specifically the Do-It and Challenge-It sections, seem to have resonated strongly with participants and carried over to activities outside camp based on parent feedback. This suggests to us that embedding

an entrepreneurial skill set at a very young age through structured processes may actually translate into longer-term confidence building in the exploration of creative solutions to problems. At a later age, this early exposure will make it easier to incorporate more advanced business strategies into such thinking. Although the school-to-work movement was intended to impact all K-12 students, recent research and practice have focused almost exclusively on enriching the learning and work experiences of high school students.[13] While these are just first year results that need more refinement and focus, these initial results seem to point to the fact that, at the conceptual core, the learning block methodology are changing strategies kids use beyond just Tech-E camp. This points to further possible gains in utilizing learning blocks to introduce kids to entrepreneurial thinking before they reach high school curriculums designed towards such.

Conclusion

The focus on developing entrepreneurial skills in K-8 has gotten limited attention with the focus normally placed at a much older age range.[13] By using learning blocks with Do-It and Challenge-It sections within the context of a STEAM camp, we are beginning to explore if combining project-based learning (PBL) with entrepreneurial components at lower grade levels will have longer term impacts on the acquisition and utilization of those skills. The usual desirable skills required in an entrepreneur – critical-thinking, the ability to think cross-functionally across departments and ambiguity tolerance – are essentially fundamental skills which PBL training will help to develop.[14,15,16,17]

Future work

The results from the first year seem to point to early wins with this strategy, however, more work is needed to see if such thinking will hold up over several years and if the kids will continue to utilize an entrepreneurial approach to problems. Additional work is also necessary to see what happens when these kids reach high school and meet the current entrepreneurial curriculum and the impacts such has.

We look to continue and expand upon our toolset work in this area specifically in regards to the learning block strategy with a focus on the Do-It and Challenge-It sections. We also want to see if kids that were exposed to this methodology continue to implement such as they grow older and if they are more prone to be more entrepreneurial at a later age as opposed to their peers which were not exposed to such a strategy.

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