FULL STEAM AHEAD: LESSONS LEARNED FROM TECH-E CAMP

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Abstract

Maker camp is the buzzword of the current environment. The concept behind these camps is centered on the engagement of kids through hands-on creation of a wide variety of objects. The Learning Environments group at the University of Texas at El Paso (UTEP) has embarked on a project to incorporate the maker camp strategy into a more formal process of creating sessions using learning blocks which utilize a Project Based Learning (PBL) model at their core. This type of strategy supports the hands-on components of a maker camp combined with the instructional strategies of active and Project Based Learning in a simplified planning tool. The design could then become a template moving forward. Our research explores what impact using such a strategy had on our Tech-E Camp hosted at the Undergraduate Learning Center at UTEP, as the technology challenges pertaining to the engineering field that made up the basic concept of the camp.

The results of our findings will hopefully provide future maker camp planners with a tool to help them design camps which connect expected learning outcomes toward an application to future degree programs. We look at online components that allowed participants to log and share their progress while participating in camp. We also examine feedback from Tech-E campers via pre- and post-assessments.

Introduction

Creating engaging and meaningful content for a maker camp can be challenging. The task of organizing different hands-on activities while making sure students of varying ages and abilities meet the learning objectives can be a very demanding one. In order to promote STEAM (Science, Technology, Engineering, Arts and Math) through outreach and engagement within the K-12 community, we developed our first iteration of a maker camp called Tech-E, short for technology exploration. This being our first attempt at such an endeavor, we developed two camps of differing composition in order to obtain information based on a wide range of ages, knowledge levels and overall experiences for both campers and facilitators. This was also done to obtain information and results to be used in the development of future camps.

The first camp was composed of a mixed group (male and female) of 38 children representing kindergarten through 8th grade. The second camp was composed of 16 female high school students representing the 9th through 12th grades. Each camp consisted of four-hour sessions for five days and there was a week in between each camp to allow for the preparation of materials, lesson plans, and venue. Along with research and student development, the main goal was to make a positive impact on student learning in STEAM through fun and engaging hands-on activities and challenges. Through these activities these younger students could perceive STEAM as something inspiring, fun and attainable; as the means to envision a career within the STEAM disciplines.

We identified the activities, challenges, and expected outcomes, while at the same time, design a structure that could adapt and be scalable for both camps and for future Tech-E summer camps. After reviewing a wide variety of strategies and methodologies [1,2,3,4,5], we developed a structural process to set up a maker camp with a focus on STEAM using a PBL foundation but with a new approach. This approach consisted of successive, interconnected sessions that were task-oriented and became increasingly more difficult as the students learned and progressed each day within each session and activity. We called this approach learning blocks. Each day had a set of timed blocks (activities and challenges) starting with the most basic skills, tools and activities that each student could build upon to gain the necessary skills and knowledge needed to be able to move on to the next learning experience. Within each activity as well as through the connection from one block to the next, students learned successively through each day until the end of camp. Through this progression they were able to master most if not all of the challenges and learning outcomes.

In this paper, we look at some examples of sessions based on these learning blocks and we examine if the camp met the expectations of the campers based on pre- and post-assessments for particular learning blocks and the end-of-camp surveys. We will also look at their level of engagement during activities as well as how formative assessment was built into the camp through one of the self-reflection pieces that was part of the process.

Materials and Methods

The primary design strategies for our camp were based on the implementation of learning blocks, which were strongly focused on formative assessment strategies, Blooms Taxonomy, alongside Project Based Learning, Team Based Learning, and Deep Learning strategies. [6,7] The two Tech-E summer camps discussed herein had a mixed group of K-12 grade levels. Camp 1 was composed of a total of 38 students, both male and female in grades K-8. Camp 2 was composed of 16 female high school students.

An additional strategy incorporated in the design was the use of a "Challenge-It" session where campers would get to play with a set of included interactive pieces (littleBits, iPad, Legos, computer parts, etc), and learn how to build something, work as a team to achieve a given objective, and ultimately accomplish the challenges identified for that block in order to move on. As students progress through the camp they became better acquainted with their peers and gained the knowledge and skills to be applied in future Challenge-It sessions. Learning blocks were broken down into sections with specific expectations as shown in Figure 1.

The learning blocks were divided into different categories, subjects and sections. Learn-It sections were 10 minutes in duration with an introduction consisting of brief explanations of the theory, purpose of the activity, and expectations with facilitators providing fun and engaging presentations using videos and live examples. The emphasis here was to provide a summary of the key terms, topics and strategies without elaborating in regards to specific solutions or challenges. This gave campers a basis for understanding the key concepts and knowledge needed to accomplish the identified tasks.

After the Learn-It session, campers were given different challenges to complete. The duration for these ran between 40 and 50 minutes. Each challenge required campers to apply what they had just learned and demonstrate mastery of the concepts at their various skill levels as they progressed through camp. They were required to have challenge answers (which may include designed or constructed pieces) checked and approved by the facilitators. As the campers showed competency in their ability to complete a challenge and with time remaining in the session, they were given an opportunity to "unlock" or proceed to the next challenge. These new challenges were more difficult and required more in depth use of concepts.

This structure required campers to demonstrate mastery of core content areas before moving forward. An example of a learning block was the Electro Flux Session. See Figure 2. Campers were exposed to a concept of electricity and electrons with a presentation which included video and graphical examples as well as an introduction on how to use their littleBits Kit (littleBits is an open source library of electronic modules that snap together for the purposes of prototyping, learning and entertainment.). Campers needed to understand how an electrical circuit works in order to accomplish the next challenge which would test if they completed a working circuit. The campers were given the first challenge which was to build a robotic character (animatronic) that would move and talk. In order to be considered a “Young Explorer” the camper needed to complete two activities at this level. If the camper finished with these activities he/she would move to the following challenge to be considered a “Technology Designer”. This process would continue until they finished all the activities and achieved the highest ranking or the time of the session was over.

WordPress was used as a tool to create a multisite repository to allow each camper to have an individual e-journal to post their reflection pieces for each session. The reflection pieces of the blocks allowed campers to assess their own performance and identify areas in which additional assistance or knowledge was needed. In addition to the reflection assessment [8], a pre- and post-assessment activity was completed by campers in

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.

Figure 1: Learning blocks used to guide camp activities.

Teaching Session

Outline

Intro to electricity and electrons; Electricity is movement of tiny particles; charge - Show power piece
Video and graphics
Move into switch and current example and analogy; exercise - Show switch piece
What can electricity do for you -> circuits to do something; Speaker/LEDs/Motor
Input/output Sensors

Young Explorer Challenges

We are going to build a robotic character (animatronic) that moves and talks.

Activity 1

Construct your character.

Activity 2

Use little bits to animate your character to make the head move.

Technology Designer Challenges

Activity 1

Have your character react when its detects a sound.

Activity 2

Give your character a voice using the app on your iPad.

Digital Apprentice Challenges

Activity 1

Remotely have your character move using the cloud bit and your iPad to trigger the movement.

Activity 2

Remotely have your character move to look at someone else in your group.

Figure 2: Learning block for Electro Flux Session.

several sections throughout the camp and we show an example in the *Results* section. Campers were asked to use an e-portfolio to write a reflection piece about their work for each of the learning blocks and include how they could improve upon it. Moreover, they collaborated with other campers to come up with a collaborative assessment [9] as to how their final product would solve a challenge/program in comparison to one another. Students had the opportunity to reflect, share and assess their understanding of the concepts in writing as well as with a self-recorded video or photo. Once campers finished all their activities for the day and completed their self-reflection pieces (checked and approved by the facilitators), a 3D-printed merit badge was presented for mastery of that day's activities. By the end of the camp a total of five badges were awarded if campers completed all skills.

Results

The first set of campers (38 in total) completed a total of 218 reflection pieces, which accounted for 56.0% of all their activities. The second set of campers (16 in total) completed a total of 133 reflection pieces, which accounted for 86.3% of all their activities. This was expected as camper challenges increased in difficulty. It was not expected that the K-8 group would be able to complete all the possible challenges and the corresponding reflection pieces given that both groups were provided the same amount of time per learning block.

At the end of the week-long camps, students were asked their opinion regarding 13 areas of the camp activities. Survey results are shown in Figure 3.

Based on the campers' survey answers, the students were engaged in the camp activities and the overwhelming majority of campers responded positively that they enjoyed their learning experiences during camp. These results reflect exactly what happened in the K-8 Tech-E Camp. They too shared their enthusiasm for the process and learning experiences even though they were only able to complete 56% of the total content designed for the camp.

As an example of the content within a learning block, both camps learned how to count in binary, do a binary to decimal conversion and a decimal to binary conversion. Before starting with the binary building block students in both camps finished a pre-test to measure how much they knew about binary conversion. After the students completed the binary learning block they completed another activity to measure knowledge gained from the binary learning block and a post-test (Figure 4). Table 1 shows the average results from the graded pre- and post-activities.

Discussion

The expansion of maker camps seems to be increasing in popularity and with that, there is a growing need to create engaging and meaningful content for the campers. Incorporating the maker camp strategy into a formal learning process by connecting the learning outcomes directly to real world disciplines has yielded a very positive experience for the campers. The development of a structured process to setup maker camps using PBL foundations can impact student learning in a positive way as shown by the results of Tech-E camp. When approaching Project Based Learning in the design of the camp, the importance and involvement of Deep Learning seems to go hand-in-hand with the learning objectives we were designing. Six competencies were taken into account: master core academic content, think critically and solve complex problems, work collaboratively,

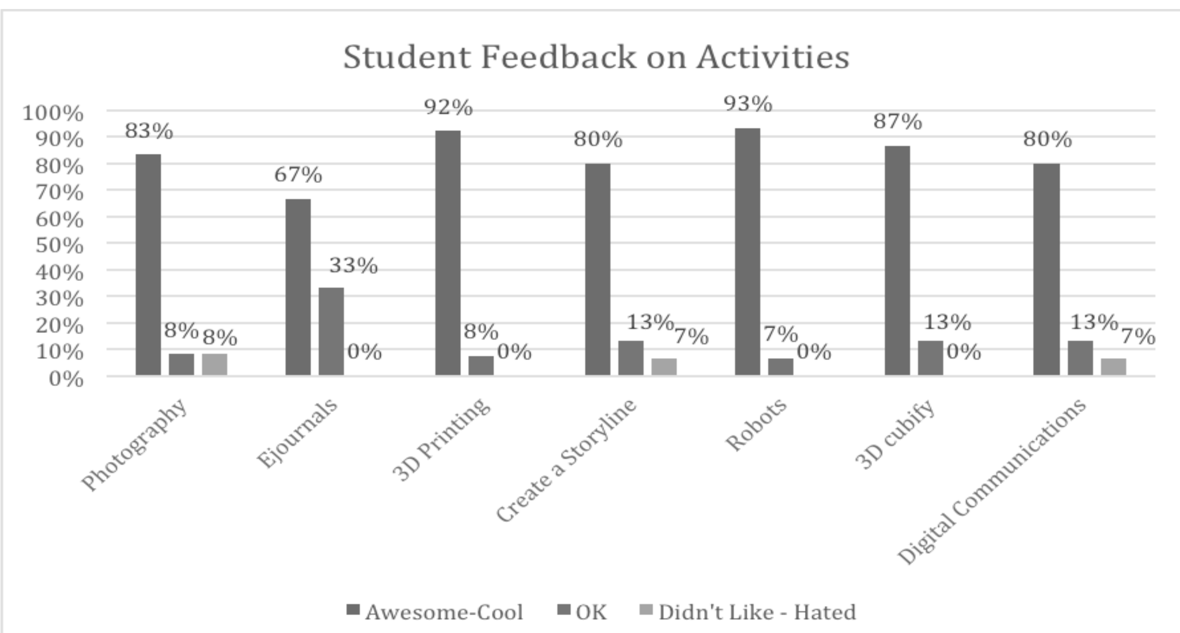

Figure 3: Feedback given by participants of both camps.

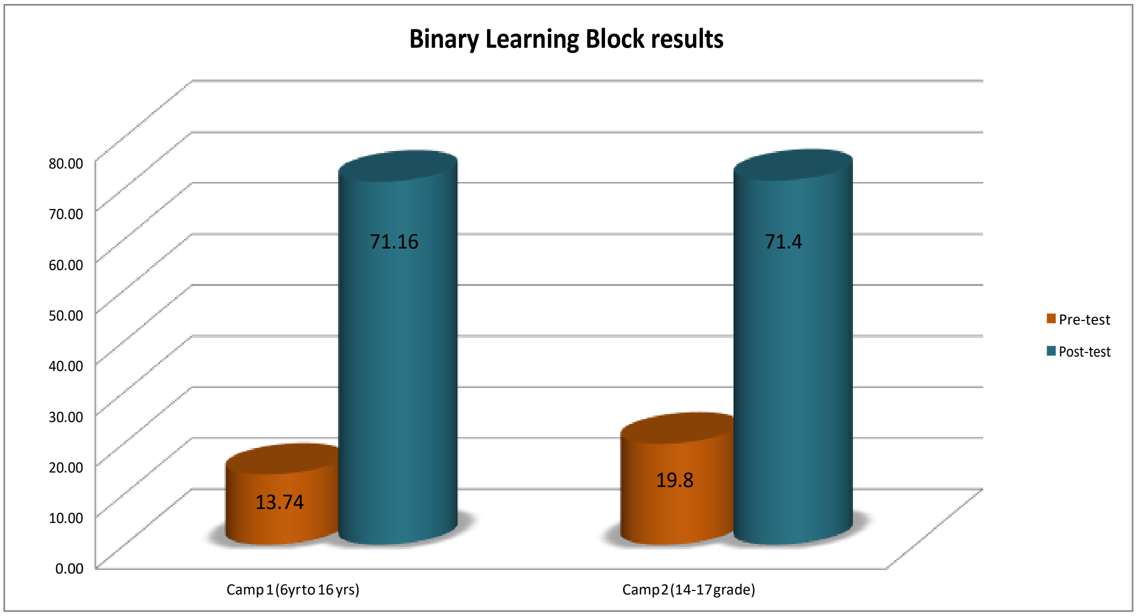

Figure 4: Results from the Binary Learning Block test.

Binary Learning Block	Pre-test	Post-test	Difference
Camp 1 (6yr to 16 yrs)	13.74	71.16	57.42
Camp 2 (14-17 grade)	19.8	71.4	51.60

Table 1: Test averages for both camps on the binary learning block.

communicate effectively, learn how to learn and develop academic mindsets. All these are vital to attaining high levels of achievement. Considering Deep Learning the "umbrella term for the skills and knowledge that students must possess to succeed in 21st century jobs and civic life [10]" as a tenet every instructor and parent strives to instill in their children can be an understatement. Through the combined use of these strategies, children are able to learn (with facilitator supervision) amongst themselves in fun and creative ways through projects and interaction. "Initiative, conscientiousness and perseverance, all can be developed with the right teaching" [11] and be used as stepping-stones towards a glimpse of what a future career can be. However, much more research is needed in order to be able to expand this process to the various area of engineering, each with its own complexities.

Conclusion

The creation of meaningful and engaging content for maker camps can be a daunting task. However, the potential that these camps can have for motivating and inspiring students to seek higher education and pursue a career in the STEAM fields is very exciting. To this end, camps need to have a clear and defined structure to map the learning outcomes to real world experiences and careers.

The results from our use of learning blocks along with Project Based Learning, Team Based Learning and Deep Learning has shown that students can be kept engaged in camp activities and for the most part the learning experiences are enjoyable. Therefore, these strategies can be reliable tools in the creation of content for maker camps that incorporate engaging lessons and activities that result in positive outcomes. There is an emphasis from the education system to help children become effective thinkers. The content of Tech-e Camp goes beyond the grade level standards and helps campers use critical thinking skills to become creative problem solvers.

At the same time, one of our successful objectives was to introduce STEAM content in a fun and engaging way. K-8 campers were given a positive model of math and science with a glimpse of real-world applications, experiences and career opportunities awaiting them as they dream and become the leaders of tomorrow. As some professors stated in the PBS News Hour presented in the "Teachers Embrace 'Deep Learning,' Teaching Practical Skills" piece in 2013:

> "It's not just what students know that will shape the course of their adult lives. What matters as much as who they are, and how they see themselves, and that starts at a fundamental level with how each child views their own capacity to learn […] One of the possible pitfalls that people from the outside might see in this learning is that it's all hands-on, it's all fun […] What they need to know is that, really, fundamentally looking at what do kids need to know. (Deeper learning) It's meaningful, and kids can apply to these situations, that's…that's something that's *[sic]* fundamental."

Future Work

In our 2017 camps we look forward to continuing the dissemination of STEAM content along with continued research that includes the assessment of a successful camp. This second year of study may unveil different results and trends with different groups of students. The research and continued refinement of camp content will allow for development of camp tool sets that will provide lifelong learning and critical thinking skills to a new generation of scientists, engineers and future problem solvers.

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Biographical Information

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 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. He also collaborates in the Learning Lab team to explore and implement new educational strategies in the classroom. He has a Master's 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.

Mike Pitcher is the Director of Academic Technologies at the University of Texas at El Paso. He has 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. 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.

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 student 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. His ambition is to encourage students to focus in science, technology and engineer abilities in order to expand their professional potential.

Pedro Arturo Espinoza has 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, he 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. He received his Bachelor of Science degree in Electrical Engineering and a Master of Science in Engineering with a concentration in Engineering Education from UTEP.

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. He received a B.A. 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. He works on research and development of applying the creative process to workshops, trainings and student engagement. Currently de is doing extensive research and deployment of emerging technologies to redefine the classroom, mentoring and excellence through student interaction.

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. He was 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. He 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. He is committed to the highest level of service to provide an exceptional experience to all of the UGLC guests. He 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. He 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. He is inspired because he enjoys working with people and technology in the same environment.

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.