

MAKER: Come to the Dark Side—We Have Cookies: Creating an Interactive Display to Engage Everyone in STEAM

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.

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.

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, where 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.

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.

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.

Dr. Peter Golding, University of Texas, El Paso

Professor in the Department of Engineering and Leadership at UTEP.

Alfonso Pruneda, University of Texas, El Paso

Alfonso Pruneda is currently enrolled as a full-time student at the University of Texas at El Paso (UTEP) pursuing a degree in Electrical Engineering with an emphasis in Computer Engineering and a minor in Computer Science. In early 2015 Mr. Pruneda started working at UTEP with Academic Technologies or more specifically the Learning Environments division. He has had the opportunity to work with an amazing team who's main goals is to implement technology inside and outside the classroom. Mr. Pruneda has had the opportunity to personally help students and faculty, work and maintain 3D printers, and program and develop iOS applications for the University. He has also had the opportunity to help in a summer camp that was focused on STEAM where kids from all ages learned about all sorts of new technology and arts in a fun and interactive way. Mr. Pruneda aspires to keep learning something new everyday and to one day use that knowledge to help better this world.

Ms. Sara Soto, Academic Technologies

Ms. Sara Soto currently works as an Undergraduate Research Assistant at NASA's Center for Space Exploration and Technology Research at The University of Texas at El Paso. She will obtain a Bachelor's of Science in Mechanical Engineering by May 2017. Her willingness and quality of work contributed in assisting and managing a subset of the only open 3D printing lab implemented by Learning Environments within the university. Her leadership and expertise made it attainable to be in charge of maintaining and running various kind of 3D printers. Not limited to just technical skills, Ms. Soto provided workshops on how to use 3D CAD design software and cloud-based 3D printer management. Selected in NASA's Reduced Gravity Education Flight Program in 2013; experienced and conducted an experiment under zero gravity conditions. Presently, Ms. Soto is working on the development of Chrome- X, a 2000-pound-force rocket engine. Specifically working on the water test setup that is going to analyze the injectors made for the rocket. Being part of Shell Eco Marathon team for the University, Ms. Soto works on creating a fuel efficient vehicle to compete against other universities all over the Americas. Her determination and beliefs in teamwork and hard work are key points that thrives her to be successful in all her classes.

Erik Lopez, Academic Technologies

Innovation has always played a key role in Erik's life. His passion towards technology led him to pursue a Bachelor's of Science degree in Electrical Engineering at The University of Texas at El Paso. In the process of experimenting with the different electrical components, Erik has applied his creativity to a variety of mediums including 3D Video Mapping, Rear Projection, App User Interface, and Arduino based projects among others. With the contribution of his fellow coworkers, Erik discovered new tools in the media development field in his first year as an employee of Academic Technologies. The cooperative environment in Academic Technologies has improved Erik's ethical, professional and personal involvement during the past years.

Mr. Gil Paquian Jr., UTEP Academic Technologies

Gilbert Paquian has always been fascinated with how things work. During his undergraduate career pursuing a degree in Mechanical Engineering at the University of Texas at El Paso, his project-oriented work with Academic Technologies and the completion of an internship with W. Silver Incorporated, a local steel mill, were able to satisfy his curiosity learning about the inner workings of various machines, electrical components and computer software. After participating in the Texas Tech University Summer Accelerated Biomedical Research Program in 2012, Mr. Paquian decided he was going to tackle the most complex machine in the world: the human body. He is currently pursuing his Master's of Science Degree in Biomedical Engineering at UTEP, focusing on developing new applications for inkjet cell printing: a novel method for cell deposition, with applications ranging from cell sorting, gene transfection, and in vitro tissue generation, along with many others. He hopes to use this technology to quickly and efficiently generate induced pluripotent stem cells, which can then be used for medical research, regenerative medicine, and developmental studies.

MAKER: COME TO THE DARK SIDE – WE HAVE COOKIES: CREATING AN INTERACTIVE DISPLAY TO ENGAGE EVERYONE IN STEAM

Abstract

In a not so distant place, in a galaxy much similar to our own we find ourselves delving into the “dark side” of things to engage students. Find out how a somewhat non-traditional approach to student and community engagement has led to huge interest in the Science, Technology, Engineering, Art and Math fields at The University of Texas at El Paso.

This Maker demonstration will showcase how utilizing a theme such as Star Wars creates a framework for student exploration into the Maker field. We will present multiple Maker components created by students to work both independently and to become part of a larger interactive display focused around a common theme. Each Maker piece will have accompanying instructions on how to design and build it. We will be providing the larger framework guidelines to be able to replicate such an interactive display in a variety of academic programs (K-12 to college). This approach allows for students’ personalized learning on their own Maker project while bringing into view the bigger picture of the needs for design specifications and the utilization of skills outside their traditional areas of study. The Maker components include Arduinos, LEDs, stepper motors, 3D printed objects, etc.

Thus begins a new hope for STEAM. It is a period of academic unrest as we venture to the “dark side” and bring about a period of personalized engagement. Help us in our battle to win against the “SAGE ON THE STAGE” and their power to destroy an entire learning experience. USE THE FORCE of ENGAGEMENT to make a new future for STEAM.

Introduction

A long time ago, in what can seem a lifetime or a galaxy far, far away, most people can fondly remember growing up and (*depending on the age group*) having played with some iteration of Meccano, Tinker Toys or Erector sets that were bought, handed down, found and pilfered among other childhood memories. Other generations would have grown up with its simpler and modernized versions: standard colored wood blocks, Legos or maybe something high-tech like K’NEX among a myriad of other fun, educational and sometimes even dangerous play sets. Yet undoubtedly besides hours of entertainment, these sets were able to do what many schoolteachers strived for but never fully obtained: ***A completely engaged student that is focused, learning and having fun in the process.*** Fast forward to the present and you are immersed in a hodge-podge of multi-age wannabe scientists, avid do-it-yourselfers, artists, tradesmen and eager *Padawans* that learn and teach through open source software, via video posts, in forums and in Fab Labs around the world that become a “wellspring of innovation, creating new products and producing

value in the community [...] some become entrepreneurs and start companies¹". You are immersed in a worldwide phenomenon. You are immersed in Maker Culture.

Movements like these have always existed in some way, but never in such a massive and diverse manner as we have seen recently. Many of these sprawling communities are so new there is little scholarly information about them, yet the media has constantly talked (*and quite favorably*) about the subject. Adweek magazine describes Makers as:

"The umbrella term for independent inventors, designers and tinkerers. A convergence of computer hackers and traditional artisans [...] Makers tap into an American admiration for self-reliance and combine that with open-source learning, contemporary design and powerful personal technology like 3-D printers. The creations, born in cluttered local workshops and bedroom offices, stir the imaginations of consumers numbed by generic, mass-produced, made-in-China merchandise."²

In The Maker Manifesto³, there are nine maxims that are vital to the movement: Make, share, give, learn, tool up, play, participate, support, and change. They are the way in which Makers interact in their communities, Fab Labs⁴ and forums, where the users via feedback, suggestions and open critiques are able to interact and improve their designs. Similarly enough, said maxims coincide in many ways with the approach we take when creating an interactive display through a Maker Session.

Materials and Methods

In Maker activities, there are some unspoken rules that are vital and must be upheld for a fully engaged student: Experience is not necessary, the skill level, knowledge, mastery and experience of the student is not important, or as important as starting from *the known* and then cater in a more personalized way to foster growth and confidence. Comfort zone is personal; the activities will help the student break out of that comfort zone through self-pacing and guidance directed at his learning style or skill level. Failure is encouraged; unlike the traditional exam-based schooling methodology that penalizes mistakes, in Maker culture failure is not only expected, it is fostered and encouraged, given that through mistakes, failure and perseverance, students are able to prototype, practice and master the acquired skills. At the same time the student is able to achieve through self-reflection and perseverance the first three levels of Bloom's Taxonomy without additional evaluations or even awareness of such⁵.

In Maker culture the richness and diversity in gender, disciplines, skills and personal cultures is unimportant in the sense that everyone is welcome, everyone can contribute, everyone can learn and everyone can share; but this richness and diversity is also highly encouraged because each individual that contributes and shares is able to do so from their own context and experience to make the projects better.

The Maker Session activity will entail 20-26 college *Padawans* at The University of Texas at El Paso from varying disciplines ranging from Art, Electrical Engineering, Graphic Design and Biomedical Sciences, among others. Their challenge is to come up with the workflow to create an interactive display that uses Arduino micro controllers, varying LED lights, stepper motors, 3D printed objects, 3D renderings in printable .STL formats, a soldering kit, wire, batteries, electrical components and other household items

like paper, glue, string, markers and tape. Using these components, the students must be able to make and/or assemble an interactive display that can be used to promote STEAM in a K-12 and 12-College level. Students must also be able to convey the struggle between *the force* and *the dark side* from the Star Wars universe to which people can choose one side (teaching method) over the other, showing in a live-setting the preference for which the majority leans toward.

Under the premise that our UTEP Padawans will show and teach participants who will most likely be teachers, counselors and community leaders, they must develop two sets of instructions. The first set is directed for facilitators and people running the activity, where our Padawans must write a rubric that communicates the scope of the activity, the expectations, the methodology, pedagogy and its ease of application, revision and customization. If any facilitator wishes to modify the activity, if they believe it can be improved or might not have some of the components readily available, they will have the resources and knowledge to do so. After all, that is the essence of Maker Culture.

The second set of instructions will be directed to the prospective attendees (future Padawans, also known as Jedi Initiates) that will showcase the actual steps to make the display. Our Padawans must write what is essentially technical writing and convert it to very simple and concise instructions that must be fun, engaging and easily understandable across a varying age range. They must also draw the diagrams of how the pieces and components fit together and create/design other supporting documents, diagrams and 3D print files that can be used for the activity.

After the attending participants are finished with the Maker Session, they must be able to understand the activity, its scope, the instructions and then be empowered to take said instructions, materials list and other support files to replicate and/or expand the activity in their own classroom, communities and spaces. The facilitator will print out these instructions. It is highly encouraged to use colored paper, or present said instructions to her/his own Padawans in creative ways in order to initiate engagement.

The use of a non-traditional approach begins with the concept of starting with *the known*. Engagement occurs by building a *Launchpad* to the imagination through shared, collective knowledge where popular culture, *i.e. Star Wars* can play as the baseline to spike interest. From there, the Star Wars universe is unveiled and serves as a sounding board where the *Dark Side* becomes the *lure* with which we engage students to work in cohesive groups that are able to simultaneously critique and support their peers through shared activities that are underlying as project-based learning opportunities⁶.

Results

The obtained results can be presented on multiple levels. The first level can be understood in the Jedi Master-Padawan⁷ (*our team as lead researchers - our UTEP students creating the Maker session*) scenario. In that first level we can see the richness in the cultural, discipline and experience backgrounds each of our Padawans bring to the group, as well as the cohesion, roles and different responsibilities each member assumes. It is of vital importance to discuss and understand the viewpoints, approaches on challenges, creative processes, revisions and at the different problem perceptions each member can encounter or discern based on their own experience and through the lens of

what their own disciplines offer. While an engineering student might find the electrical components working properly, the designer might notice the way in which the components are arranged might not be presented in a visual user-friendly way. Where the liberal arts student might see the whole setup as something culturally or contextually significant and at the same time everyone as a whole can attest if all the minute details and minor components can contribute to the bigger picture.

The second level can be understood as the Padawan- Jedi Initiate (*our UTEP students-Maker Session attendants*) scenario. For that interaction, Padawans have worked together under the Jedi Master (our) guidance to complete the Maker Session. Through that interaction they have managed to modify, improve and streamline the process to the point where every member of the team understands the complete session and is now able to present and train a new batch of Initiates.

Through this interaction there is a mentor-apprentice circle that thrives on a project-based learning method, where our students began as Jedi Initiates and after practice, different iterations, modifications and tinkering, are able to master their skills, become Jedi Masters and take on Padawans of their own. This in turn will enable the Maker Session attendants to eventually master such skills and take the Maker Session model and move from Jedi Initiate, to Padawan, to Master Jedi and take Initiates of their own and so on. Thus simulating once more the Maker culture process where everyone participates and gains new skills with each iteration.

Discussion

Maker Sessions, camps and communities are a phenomenon that is rapidly growing because of the ease of use and the high engagement it can provide to an all-age audience. These endeavors that although focused for a K-12 segment, can also provide much needed technical, entrepreneurial and social skills for all ages, especially for women in STEAM. For example, statistics from Etsy, an online craft community show that its sellers are “88% women, 97% run their businesses from home and they are dispersed all around the US. Etsy sellers don’t identify as hobbyists. 74% consider their online shops as businesses. They are a new kind of “start-up” of independent, self-sufficient Makers⁸”.

Places like Etsy, Fab Labs and startup sites around the country and the world can translate into different levels of engagement and STEAM proliferation. The first level includes potential students that can be engaged at an early (*highly impressionable*) age to participate in STEAM programs through outreach, Maker Camps and fun, innovative projects that can stimulate interest, the imagination and relate to them on a deeper, personal level. The second level can include people that will be able to obtain a future source of income from *Making* out of their own homes, via social media and websites like Etsy, as well as people that have acquired a STEAM education and are able to find employment or employ people for a Fab Lab, another industry or scholarly related endeavors. The third level, which would be the highest level of STEAM engagement would include people that through a STEAM education, Maker Camps and community involvement are able to dream, visualize and feel empowered to begin their own startups and become creators, the innovators and the Makers of tomorrow.

Conclusion

The fact that Maker camps and sessions seem to be growing in popularity only validates the fact that additional resources and tools are needed to connect these camps with foundational strategies to provide complete solutions on STEAM–centric activities, communities, schools and vocational programs that can help potential students become more curious, imaginative and engaged. The act of creating, of making is intrinsic to our humanity.

The process of developing a Star Wars-based Maker Session has proven a valuable resource to engage students and people from wide-ranging ages, experiences and interests. When utilizing Bloom's Taxonomy on this process⁹, the first three principles of **knowledge, comprehension** and **applications** are unknowingly achieved by project-based learning opportunities. That is achieved by mere interaction and cohesion among peers while creating, revising and reiterating all their skills, acquired knowledge and the steps to create a Maker Session and perfecting it to the point of dissemination. Once the Maker Session is ready for presentation, our students have already mastered the three additional levels of **analysis, synthesis** and **evaluation**. They are now able to evaluate the outcomes where they have developed their skills, attitudes and values. At this point the issues of analysis and synthesis have been applied creatively and the students themselves are already engaged in a higher order of thinking. They are inspired to reveal and share the creative potential obtained through a seemingly unorganized and chaotic workflow and yet, they are now engaged in their own learning, thus ready to engage and pass-on the experience to future Makers.

Future work

Creative acts are fundamental for engagement, teaching and most importantly, learning. In approaching students through Maker Camps, we are able to engage them in STEAM;. However there is still very little scholarly research done in this field even though most of the rough material, the Makers, the communities, the spaces and the approaches are already available and growing online, outside academia. We look to continue and expand upon our projects, methodologies and different approaches to engage with students and teachers that wish to utilize Maker Camps. Studies and statistics show that these activities are growing among all segments and age ranges of the population and it's vital to harness these learning opportunities in outreach and regular classes in order to promote and foster the innovators of tomorrow.

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