

Work in Progress: FLEx—University X’s Mobile Technology Classroom

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Work in Progress: FLEx - Iowa State University's Mobile Technology Classroom

Abstract

This proposal describes the FLEx (Forward Learning Experience) program, a mobile learning environment in a 16-foot trailer designed to deliver advanced technology outreach to students around the state of Iowa. A joint effort of Iowa State University's College of Design, College of Engineering, and Extension and Outreach, the FLEx has engaged 35,000 K-12 students, educators, and families in 171 events since the fall of 2014.

The trailer provides hands-on experiences with virtual reality, immersive visualization, prototyping, augmented reality through an Oculus Rift, interactive circuit building, a Makerbot for 3D printing, and a CNC (computer numerical control) router for complex precision material cutting. The FLEx utilizes learning theories such as constructivist, experiential and situational learning, universal design and game theory, and supports tinkering, play, and self-directed exploration. An early informal program review showed that Design and STEM interest among grades 3-8 increased 72% due to exposure to the FLEx.

The FLEx is a groundbreaking program which improves a land-grant university's potential to reach its state constituents in a novel and focused manner. The program has received national awards, recognition, and interest in its early and initial configuration.

Future work will partner with University Extension and 4-H to build capacity to increase exposure and provide this experience to many more students across the state, with a particular focus on supporting rural students and underserved communities. Research is ongoing and being formally proposed to show the educational benefits of the program through workshops and long-term positive outcomes in partnership with state-level educational task forces.

Introduction

The Forward Learning Experience (FLEx) program is a mobile learning environment for advanced design technology outreach at Iowa State University. The first prototype was created as part of an Industrial Design graduate studio in the summer of 2014. The ideas combined universal concepts about design and design thinking, learning theories for informal environments, concepts about problem solving, Makerspaces, the Internet of Things (IoT), STEM and STEAM. The small studio of nine graduate students and one instructor worked on these aspects, looked to the Iowa Core¹ for educational connections, and incorporated 21st Century Skills and the Universal Constructs (4 C's) into the design. Deeper researching and ideating recognized major differences between 20th Century approaches to education and new opportunities for learning and solving problems.

Today, digital technology is pervasive with mobile devices and the internet providing an abundance of information, knowledge and opportunity. According to Richardson², by 2020 more than half the US workforce will be "freelancers, consultants and independent workers." This lines up with today's workforce trends where many individuals work multiple part-time jobs. Richardson also notes a shift in students needing to master content to being able to master learning. This aligns with a base concept Brown³ has put forward describing, "agency" as active

participation, creating and building. A 21st century strategy for learning by design encourages agency with each individual actively experiencing new technologies tools for creating and communicating in a combination that supports deeper experiential learning.

Equipment

Two types of experiences and tools emerged from the development of this project, which overlap in concept but actively engage the participants individually and directly. The two types of experiences and tools encompass the ideas of “SEE” and “MAKE”. These focal points have also been described as “visualization” and “fabrication” in the Industrial Design Department at Iowa State, and the two parallel the ideas of “digital prototyping” and “real prototyping,” which is also part of iterative thinking in design and STEM.

SEE Module	MAKE Module	VR Wall
Road Case	Road Case	7' diagonal Dalite rear projection screen
(2) Oculus Rift DK1	MakerBot Mini 3D printer with example prints	M-Vision Cine 320 3D projector
(2) mirrored video display monitors	Video display with examples	Custom PC
Alienware Alpha	(5) LittleBits sets	3D glasses
Mac Mini	Mac Mini	VRAC modified Razor Hydra Motion Controller
Augmented reality iPads		VR JuggLua software

Table 1- Inventory of FLEx equipment

The SEE module primarily involves two sets of virtual reality headsets. One presents a serene Italian Tuscany Villa Oculus Rift demo, where orientation and navigation in a virtual world is self-directed and non-threatening. A keyboard and mouse augment the headset for movement and orientation around the space in a manner very similar to computer games such as Minecraft with the interface remaining very simple and unobtrusive. The Villa, highly textured and realistic, creates an easy opportunity for being introduced to virtual reality.

The second headset is programmed with a custom virtual roller coaster on central campus at Iowa State - a familiar setting to many Iowa residents. This ride requires only the headset and provides a very visceral virtual reality experience with the roller coaster rushing between and through buildings and careening up, down, and around central campus. This is often a highlight experience of the FLEx, as the feeling of being there is heightened by the perceived action of the roller coaster. The SEE module is also an opportunity to present smart-phone virtual reality like Google Cardboard or augmented reality experiences through tablets, which are more easily replicated at schools or homes due to the lower cost of entry.



Figure 1 - Student reaction to the Oculus Rift headset

The MAKE module realizes a more physical space of interaction with a small 3D fused deposition modeling (FDM) additive printer. Previously completed 3D prints (such as Pikachu or Iowa State's campanile) serve as examples, and a real-time 3D print with the printing software and digital model resources are displayed. Videos showing a variety of current real-world and authentic 3D printing solutions such as buildings, chocolate, medicine, prosthetics, circuits, car chassis, and biological matter are also shown, and these examples let the technology demonstrate tangible opportunities to FLEx participants.

Additionally, the MAKE module offers hands-on, creative modular circuit building. Little Bits are color-coded modules that magnetically snap together for straightforward assembly, manipulation, and experimentation. These electronic building blocks are pre-assembled, so students simply snap them together like Legos instead of first learning to wire up electronic components on a breadboard. Students have the option of following along to create pre-built circuits from a workbook, or they may choose to experiment and make their own creation. This becomes an entry point to introduce the concepts of programming, which can be expanded in longer term workshop engagements using a Little Bit Arduino board. By allowing the logic of circuits to be physically manipulated in simple terms, the ideas of input, output, sliders, switches, splitting, loops, and sensors begin to have real meaning. 3D printing in the same space as circuit bending allows a crossover of prototyping objects and electronics which is an important learning connection to the emerging internet of things.



Figure 2 - FLEx trailer at an event in Van Meter, IA

All equipment is transported to the site in a 16' trailer (Figure 2); the program can be held in and around the trailer if needed, or the equipment can be offloaded into an interior environment for a more traditional classroom or lab-like experience.

Funding

The initial funding was done in conjunction with the Industrial Design department at Iowa State, utilizing some initial startup funds provided by the University Provost for an "experimental classroom." In addition, the department has provided partial appointments and a graduate student as additional support since the inception of the

project. External funds were provided by Baker Group from Ankeny, Iowa to purchase the trailer used primarily for transportation but also as an outside classroom during fair weather opportunities, housing one module with tents over the other two modules. One additional grant for a design outreach studio was used in the summer of 2015 for some equipment, maintenance, and travel costs.

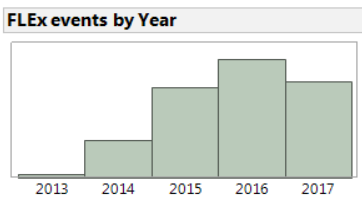
In the summer of 2016, a formal partnership between Iowa State Extension and the College of Design provided a 3-year contract for a shared faculty appointment and funds for travel,

maintenance, and upgrades to the program with the the goal to be self-sustained and/or supported in large part by external funds and grants.

Session Overview

As of June 2017, FLEEx has delivered a total of 171 sessions both on campus and around the state of Iowa (Figures 3 & 4). The number of sessions have continued to increase each year, with 2017 poised to exceed 2016's previously record total. Notable sessions and locations include the Iowa State Fair, 4-H, Women in Science and Engineering (WiSE), Precollegiate Programs for Talented and Gifted, Upward Bound, and Science Bound.

Sessions begin with a short 15-minute presentation on design thinking, STEM, 21st Century Skills, Industrial Design, and the possibilities of advanced and emerging technology. Students are asked what they think Industrial Designers do, and are then given examples of things this profession may have been designed (such as toothpaste, airplanes, chairs, etc.) These concrete,



Frequencies		
Level	Count	Prob
2013	1	0.00585
2014	18	0.10526
2015	45	0.26316
2016	59	0.34503
2017	48	0.28070
Total	171	1.00000

Figure 3 - Number of FLEEx events by year, as of June 2017

everyday, familiar examples help to put the students at ease and broaden their thinking and range of possibilities from just “art.” The presentation also emphasizes how young people will likely be expected to interact with tools that are considered cutting-edge today (VR, augmented reality) as part of their routine professional lives in the near future. The sooner students can be exposed to a real life, physical example of emerging technology and see the implications and applications, the better. Technology will of course be much more advanced when students enter the workforce in 5-15 years, but getting a baseline and early feel for the tools will help them adjust and relearn whatever is coming in the future.

The presentation concludes with a short description and walkthrough of each piece of equipment the FLEEx provides, and then the students break into small groups of 5-7 and explore each technology collaboratively; groups rotate after 10-12 minutes. This ensures each student has exposure and experience with each piece of technology. Faculty members and other interested members of the campus community are available at each station, explaining the equipment in more detail, demonstrating advanced features, and answering any questions the students may have.

If time permits, following this self-directed exploration the group is brought back together as a whole and impressions are shared. Optionally, a 3-D design module can be started, where students create an object through the 3DC.io app using a set of iPads owned by the College of Design. Popular designs in this module include the university logo, monsters, or the student's name. The file can be saved and emailed to the classroom teacher, and the student can then take the file, perfect it, and take to a 3-D printer in their community to realize the final product.

FLEx Session Locations by Year, 2013 - June 2017

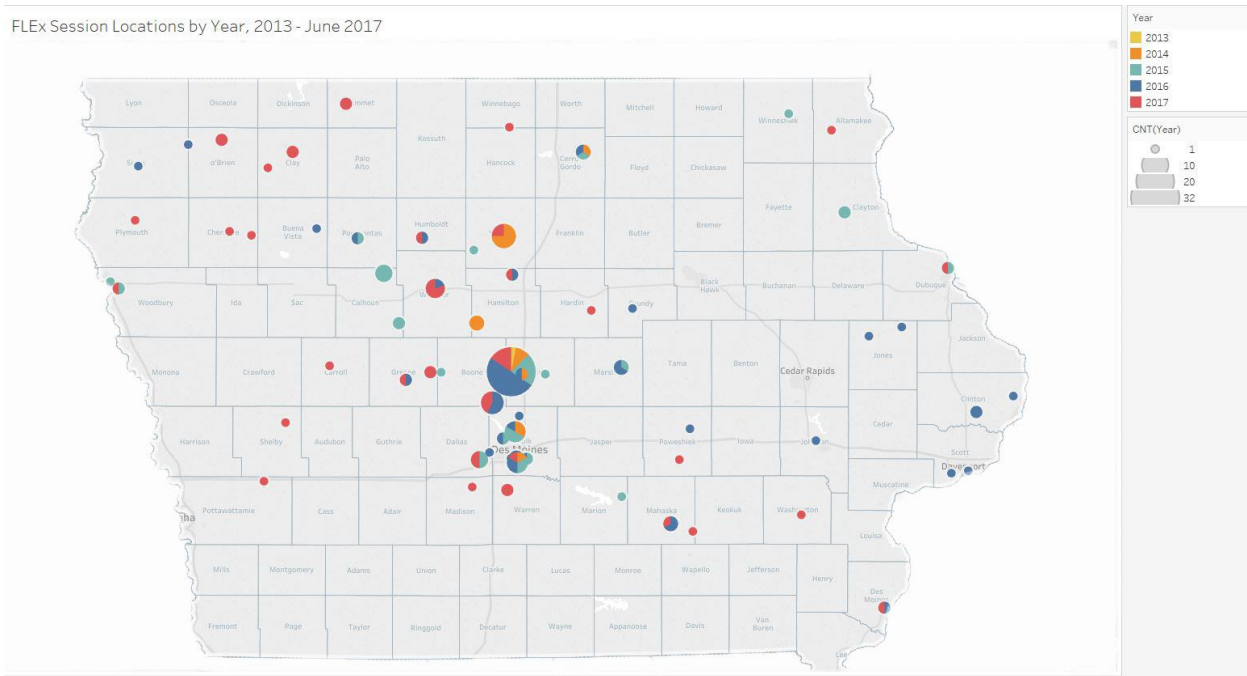


Figure 4 - Map of all FLEx events. Slices are color coded by year and circles are sized by total number of events.

New Developments

Since the launch in 2014, changes in dedicated personnel resources, technology, and funding streams have caused the FLEx program to evolve. One recent and notable program advance was a formal partnership between Iowa State University Extension and Outreach and the College of Design creating a shared faculty position with additional dedicated maintenance and operational funds for 3 years. This provides essential support for a program without a formal home base. This has been a critical step formalizing a pilot program and building future capacity. With this support are expectations that long term viability will rest on external funding. Still, the ability to reinvest in upgraded technologies and new strategies to deliver the program have moved the program forward. Logistical and extended program reach and support was realized in embedding the program in the Iowa State Extension K-12 4-H program.

Capacity building was also realized in a special related funding opportunity with the 4-H partnership. A request to build a professional learning kit as an introduction to the FLEx provided a new product to build and widen exposure opportunities to the program. Similar entry level technologies for VR, 3D printing and sample Little Bits were combined in a small luggage-sized mobile package. These were envisioned as tools for professional development, but were quickly recognized as additional scaled-down FLEx kits to engage youth for additional FLEx exposures in small group afterschool informal activities. This widens the program across the state at an introductory level but still provides traction and exposure for both students and additional logistical support.

With the pilot starting in 2014, technology has quickly evolved. A second generation form-factor with the next suite of tools has been envisioned and is being actively developed. Logistical challenges for scale and delivery are being prototyped currently. One particular technology is the

VR headset Oculus Rift that started as the Developer Kit 1.0 in 2014 and is now in a full Commercial Version 1.0 (CV1 - two generations newer than the DK1). With this new cabling, applications and hardware configurations are required to deliver this as part of the FLEx experience.

Future Implications & Conclusions

FLEx can be seen as part of a larger movement to integrate technology, experimentation, and collaboration on the college campus. Makerspaces and resource sharing hubs are becoming more common; Barrett⁴ details the status of 40 university makerspaces in late 2014, and Rogers⁵ describes NC State University's Hunt Library and the electronics hardware checkout program implemented there. Fitting with this framework, Iowa State is constructing a multidisciplinary Student Innovation Center on campus, and the University Library has recently added Arduino, Raspberry Pi, and Makey Makey electronics kits to the circulating collection so students have access to the hardware regardless of their declared major. FLEx is another, more flexible approach to technology resource exposure, and there are numerous opportunities to integrate these offerings and fit within the Iowa State University's land grant mission statement to make advanced technology available to all. Libraries and resource sharing hubs are becoming more important in the support of multi-curricular and multidisciplinary programs which are not actually housed in a particular department.

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