Reliable Analytics for Disease Prediction

(Technical Paper)

Makerspaces and their Role in Shaping Young Creatives and Engineers

(STS Paper)

A Thesis Prospectus Submitted to the

Faculty of the School of Engineering and Applied Science

University of Virginia • Charlottesville, Virginia

In Partial Fulfillment of the Requirements of the Degree

Bachelor of Science, School of Engineering

Spring, 2020

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On my honor as a University Student, I have neither given nor received unauthorized aid on this assignment as defined by the Honor Guidelines for Thesis-Related Assignments

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Introduction

In the last few years, education has undergone a somewhat drastic change, as educators attempt to find new and innovative ways to guide the learning of young engineers and creatives. One such attempt in this regard has been the adoption of makerspaces, both in grade school and on college campuses. The maker movement has taken hold globally, with some estimates placing the number of makerspaces worldwide at 2000 as of 2016. (Robbins and Langan, 2016) "Makerspace" is often used as a catch-all term for a space with relatively open access, where people can come and create something, usually without any outside guidance. These spaces often include computers with programming languages and IDE's, CAD software, and 3D printers among other things. The spaces are intended to promote creativity and learning through experience, and they (as well as other programs and spaces modeled off the same principles) have been appearing in more and more schools in recent years. These spaces, as well as the other programs and academies that have been created for similar purposes and demonstrate a coordinated push toward creating a better educated population, focused on the values of creativity, and modern, 21st century learning. Another aspect of makerspaces and modern learning is software and artificial intelligence. Along with my group, I am taking part in technical research to develop reliable disease prediction using smartphone sensors. This will be explored further in later paragraphs.

This prospectus will focus on this technical research, as well as the question of whether or not makerspaces promote creativity and problem solving in a highly structured environment. In order to address this topic, I will use the Charlottesville (and surrounding Albemarle County) public school system as a case study. I will look at multiple implementations of makerspaces within the school systems, and compare and contrast them. Research performed

will attempt to answer the following questions in addition to the main research question: In what ways does the school attempt to implement makerspaces or maker values into education? What learning experiences can makerspaces and creative learning programs make, and are they always positive? Do students involved in creative learning programs such as makerspaces perform better in terms of critical thinking and problem solving, as well as academic and professional success? All of these questions are important when evaluating whether makerspaces provide creative learning opportunities to students.

Technical: Reliable Analytics for Disease Prediction

Today, smartphones and other wearable devices are capable of collecting millions of data points about each of its users daily. However, while the potential power of this data in improving society and providing other benefits is unprecedented, there is still much work to be done in creating predictive models that can efficiently extract valuable information from this data. In the Reliable Analytics for Disease Prediction capstone project, such unstructured smartphone data will be analyzed as part of an effort to create predictive health models.

The technical project, advised by Professor Laura Barnes, Medhi Boukhechba and Lihua (Lee) Cai, specifically seeks to predict the user's health status based on smartphone-extracted contextual data. The project is a part of ongoing research conducted for the Defense Advanced Research Projects Agency (DARPA) to design and develop reliable disease detection analytics through data collected from smartphones. The ultimate goal of the research is to create " a mobile application that passively assesses a warfighter's readiness immediately and over time," (Patel, n.d., para. 5); by building predictive health analytics that utilize smartphone sensors, the onset of illnesses, concussions, or even mental health issues can be noticed in real time. In the

current stage of research, the technical team will develop the tradeoff between data collection frequency and battery life. This is an important step in the feasibility of this technology and in understanding the user's environment. By gaining a better sense of these limitations, accurate predictive models can be built without the noise of dead phones or other unwarranted stimuli.

Mobile sensing data used in this research will be collected through the Sensus Application. This app, developed at the University of Virginia (UVA), uses "event-driven architecture that triggers actions in response to changes to the device or network state" (Lockheed Martin & Advanced Technology Laboratories, 2017, p.10). This data will be utilized to create context recognition models, which determine what ambulatory state the user is in, like walking, running, or sitting. Additionally, the Sensus app will push surveys as notifications to participant's mobile phones to create additional context around the data collected. These surveys will ask questions about the user's activities immediately before answering the survey, such as the user's location, length of activity, phone position, and more. This additional collected data will allow the team to build the strong foundational truth for these predictive health models.

The technical project group consists of nine undergraduate Systems Engineering students. Because of the large size, the team is divided into three subteams: the Data Modeling Team, the Data Visualization Team, and the Data Collection Team. These teams were constructed for the currents needs of the project, and are subject to change and overlap depending on the need in each area. The Data Modeling Team will work to prove the efficacy of adaptive sensing in an attempt to find a balance between data collection and battery usage. Ultimately, the team will develop an algorithm as a potential alternative to the adaptive sensing model currently being

used. The Data Visualization Team will make significant improvements to the web-based visualization platform used by the researchers to increase understanding and context of the data they are collecting. Improvements to this platform will allow better insights to be easily accessible. The Data Collection Team is designated to complete the IRB so that the data collection among the student cohort can begin. Once the IRB is completed and approved, the team will be responsible for organizing the participants in the study.

At the end of the study, the team will deliver a recommendation for smartphone data collection that effectively accounts for a user's battery life and critical predictive data and a recommendation for intuitive data visualizations for the researchers' web platform.

The technical project is funded through a grant provided by DARPA. Additional resources include test phones and desktop computers to run software and view data. The technical project will produce a conference paper for the Systems Information Engineering Design Symposium (SIEDS) that will take place in May 2020.

Sources

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STS Research: Makerspaces and their Role in Shaping Young Creatives and Engineers

This research on makerspaces in education stems from a belief that a well educated population is necessary for a well functioning modern society. In such a society, the way we educate youth must be optimized and refined in order to build up strong minds, and create the best academics and professionals possible. In this regard, two focuses for optimal education methods can be realized. These are a focus on a robust 21st century education, as well as an education that cultivates creativity. Striving toward these values is what pushes this research into creative learning methods such as makerspaces.

The overarching research question to be answered in this analysis is as follows: Do makerspaces fit into or push back against standardized rigid education, and in their role, are they able to provide a creative education experience to students? Diving a little deeper, I want to understand exactly how makerspaces attempt this integration, as well as if it is successful. In order to fully understand this question, I will employ the SCOT framework, which examines the social construction of technology by focusing on each stakeholder group involved in its development. Furthermore, I will focus on the Charlottesville and Albemarle school system, firstly looking at the MESA academy at Albemarle highschool. This academy was built with the same values of makerspaces in mind, and is a unique approach to injecting the creative, hands on values of makerspaces into the highly structured environment of public education. The academy

has a dedicated space within the building where students attend class, complete projects, and have access at all times. The coursework is designed to promote creativity and allow freedom within projects, while still working within the confines of the Virginia education standards. In addition to being built on the values of makerspaces, the program contains traditional makerspace components within it including CAD software on students computers, 3D printers, and a laser cutter.

Some research has already been conducted into the question of whether makerspaces are actually effective in promoting creativity, with some saying that they do assist in fostering creativity in engineers. (Saioran et al., 2017). This research draws on work done by Prince and Felder, where they explore the concept of "divergent learning", which describes the process of learning by exploring a large quantity of different solutions. (Prince and Felder, 2006) Saioran and others argue that this aspect of makerspaces is one of the main ways that they promote creativity. Divergent learning is also a large part of the MESA curriculum, which strives to design open ended projects with many solutions.

In order to use SCOT to meet the goal of understanding the place within the education system for creative learning spaces and programs, we must first understand the different groups interested in the outcomes of these spaces. The desired outcomes for the students using the space include gaining real life skills, working in teams and generating new interests, among others. (Li and Todd, 2019) These outcomes, unfortunately, are not necessarily in line with the desired outcomes of other parties at the school. One such group is teachers, whose perspective will be analyzed more closely in later paragraphs. Teachers want to help students learn, but they also have strict guidelines and metrics that determine what they must teach and when. Finally

there are administrators, who are focused on other metrics which they are judged on, which may or may not correctly correlate with educating successful, creative professionals.

I have already conducted further research into the various social groups affected by makerspaces and creative learning programs. I have conducted interviews with community members who have first hand experience in different aspects of the education system.. Each of these people provides a unique perspective that is important to gaining a full understanding of the current education system. The first interviewee was an elementary school teacher, representing the interest group of teachers. She described the difficulties she faces with incorporating innovative learning techniques when students and teachers alike are consistently evaluated based on standardized test scores. She went on to say that these tests are archaic in the sense that the focus on rote memorization of facts, and do not measure creativity, critical thinking, or problem solving effectively. This interviewee's experience is the basis for my research question.

The second interviewee is a current high school senior in the albemarle county public school system. She is part of the MESA program, which will be an important case study for my research. This high school senior described her experience in this program as very beneficial, and pointed to a number of aspects of the program she believes have helped her succeed academically. I hope to interview her and others in similar programs with a more robust set of questions in the future.

This research is only the beginning, and I have plans to obtain more data from a number of sources. Firstly I plan to perform observations and investigations in local schools. During these observations, I want to see how students are evaluated, and what kind of free time and

access to current makerspaces they have. Furthermore, I want to speak with teachers who work in the makerspaces, as well as those who do not, to see if they have noticed positive benefits in students who participate in makerspace activities. I also want to interview administrators in schools in order to hear their thoughts on makerspaces. I want to understand how they view makerspaces. Do they see them as a benefit? Do they see them as taking away valuable time and resources from students and teachers?

On top of all this I want to gain a better understanding of the school system and the restrictions and requirements placed around education. I will begin reaching out to administrators who dictate how schools are run and what teachers must teach. I will also begin looking into the required curriculum for Virginia schools, and looking at how the MESA program (and others) try to provide creative resources within that curriculum.

SOURCES

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