Design Document
Final Project
MSTU 5027

Digital Democracies in the Age of the Internet of Things

Curriculum

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Introduction

"We will live in a world of ambivalent participation."[1]

In the era of connected devices and people, we must rethink the idea of personal freedom and data security. The Internet of Things (IoT) exemplifies the ways in which digital technology can become embedded in our physical environment (Manches et al., 2015). As the risks are likely to become more and more relevant due to the large amount of data collected, an essential facet in ethical design is the transparency of the technology and services in handling data and providing choice for the user. In this project, I want to highlight the need for new approaches to grant a more active role to IoT users, which will address other issues such as safety risks. The focus will be on enabling learners to easily create, setup, and control applications via IoT services and apply them to physical objects in the real world. By making the process transparent and understanding what type of data gets passed around, we can build trust between parties.

However, IoT goes beyond just technological and ethical discussions. For example, anthropologists Miller et al. (2016) have shown that the use of social media in nine different global contexts is neither influenced solely by technology itself nor by the local economic conditions, but rather by the *social* use of this particular technology of the communities studied. So by increasing the transparency and human understanding of IoT seen as a black box by many, and reframing the capacity of IoT, it will not only establish trust but disrupt its social use.

So I decided to explore the idea that by allowing students to program the device and set up the link between the machine and the object, they will develop agency over the technology. In letting them play and tinker with powerful toys (real social media platforms), I want them to view those intelligent agents as tools to broaden their creative expression and social participation. Finally, through using the affordances of paper crafts, users will build their own tangible artifacts linked to their desired platform. They will explore how they can control, access, and monitor the physical representations of personal and meaningful data.

Need

Things play an essential role in our lives, and connecting objects through IoT generates exciting opportunities and the potential to disrupt how we interpret and interact with our physical environment. By disrupting the representation of physical (e.g., paper, wires) and abstract things (e.g., data, privacy, engagement), we can shift our perceptions of our daily actions like checking our emails or liking a tweet. As we are inching closer to automation, personalization, and surveillance, seeing technology separated from its interface will allow students to perceive their digital lives differently. At the same time, we are experiencing cultural, economic, and political shifts, requiring us to reframe education in the current cultural context. With digital technologies playing an active role in creating a civic space for youth, so does enabling students to build a free, open, and transparent future. While the existence of digital technologies is a crucial enabler of youth civic engagement, the same technologies and platforms may be barriers to civic engagement, which is why I target two significant points:

1. The use of bots affected what users see online. Up to 48 million of Twitter's 320 million users are bots or applications that perform automated tasks. This contributes to increased polarization and hampers the free flow of information essential for civil discourse, policymaking, and democracy. In getting to automate some of their daily tasks, students will be able to correlate the utility of automation and how this can highlight or drown one's voice. Moreover, there is a huge

[1] Anonymous MIT professor, Pew Research Center, June 2017, "The Internet of Things Connectivity Binge: What are the Implications?"

opportunity to use automation in constructive ways to further social justice causes, whether by automating civic engagement, performing operational tasks, or promoting transparency.

2. The future of rules and regulatory attention that governs the collection, use, and distribution of consumer data and the standard of protection for online and digital content is unclear. The deregulation and the weakening of consumer protection laws undermine a free, open, and secure use of various services, such as IoT. Empowering students to access and transfer data more transparently will enable them to better protect themselves.

People are far more likely to be discriminated against with data or surveilled with data than they are to use data for their own civic ends (O'Neil, 2016). A key challenge has been the unequal distribution of data literacy, excluding from collaborative construction those that "speak data" and those that do not (Bhargava, 2014). Hence the need to:

- Be informed of the implications of IoT (physical interactions, data capture, and protection...)
- Be involved in the ethical and social risks (trolling, bots, leaks…)
- Build a sense of agency to encourage further civic participation.

Learning Goals

In defining data literacy as "the ability to read, work with, analyze and argue with data as part of a broader process of inquiry into the world" (D'Ignazio & Bhargava, 2016), we target high school students with some prior knowledge of social media platforms and programming. Students ideally would be transitioning from microbit and block programming to other microcontrollers and an arduino based language. Although the chunks of code are provided, we would want students to make connections between the written syntax and the blocks and ultimately add, modify, remix, and share.

- Students will be able to describe key features of IoT, how/what data is accessed, transferred, and used by different platforms.
  "I can see how my data is being accessed and used by ..."
  "By clicking the box, I allowed ... app to access ... information from my account."

- Students will explore ways to give meaning and connect objects to digital platforms making them more relevant to their context.
  "I want to connect my microcontroller to ... app and monitor the gaining popularity of ... hashtag."

- Students will construct IoT tangibles with civic/social engagement goals, making their participation possible and powerful. By making it easier to participate, students will want to take part as they feel their participation has a tangible impact.
  "In order to help motivate my friends to vote, I want to make it easier and accessible to them, while personalizing my message (e.g., sharing humorous content) "

Theoretical Framework

The necessity for students to understand and design with IoT technologies is unequivocal; however, the integration of IoT in education is limited. To fully understand IoT, they have to design using various components and platforms actively. I believe that creative approaches grounded in constructionist educational theories are necessary to empower learners to argue for change. We will focus on discovery, learning through social and active hands-on experiences, and designing meaningful and relevant artifacts. Students will experience gains in IoT knowledge by seeing it valuable within a context, and we will assist

them in thinking about the role of technology and theirs as active citizens in society. This project is situated within a framework of constructionism and passion-based learning.

A constructionist approach helps us ground the introduction of new technologies and concepts without focusing on technology. By making, students will engage in the design, creation, and sharing of physical and digital artifacts that promote knowledge building and conceptual reinforcement (Harel & Papert, 1991). Papert advocated for "low floors and high ceilings" in that students can participate with little prior knowledge (hence the scaffolds in place for the activity) but with ample opportunities to complexify their learning (Papert, 1980). Creating situations for physical learning may seem to be a challenge, as data outputs one most often sees on a screen, so I had to ponder how to let students experiment with ways to "visceralize," "physicalize" (Huron et al., 2014) (Willett & Huron, 2016), and make data tangible, embodied and felt. Utilizing a maker context, I encourage students to reflect on their artifacts' purpose and impact by linking them to real-world issues, a sense of community, and social participation.

Moreover, by utilizing students' interests, I want to expand on Papert's conceptualization of the context of "low floors and high ceilings" with Resnick's addition of "wide walls" (Resnick et al., 2009). By accommodating various interests, students will create a personally meaningful experience and be more likely to remain engaged and deepen their understanding. Leading through inquiry, the first step of the project with personal data/metadata and automation is helping students understand what kind of questions can be answered. Determining which platform to use and what data is collected involves creative political thinking and information retrieval skills. This will guide the creation of meaning for themselves and their communities. Having learners bring their context and lived experience will enable them to draw a richer picture of what to build with data and perhaps even challenge its use and propagation.

Humour, memes, and satire are ways of engaging with popular culture and help youth explore digital civic engagement. Teenagers favor a "personalized politics of expressive engagement," such as digital networking, self-expression, protests, and volunteerism (Bennett et al., 2010). Finding something "that ignites a student's passion can set the stage for the student to acquire both deep knowledge about a subject ('learning about') and the ability to participate in the practice of a field through productive inquiry and peer-based learning ('learning to be')" (p28. Seely et al., 2008).

Detailed Description

This curriculum focuses on high school students who already have foundational knowledge about programming (block-based) and a general understanding of electronics. However, we provide schematics and code chunks to facilitators to target the curriculum to their audiences and lower the need for prior knowledge. We also provide an online platform with more of a step-by-step for facilitators, although we recommend tinkering with the project to better understand the process.

To build with metadata and data and highlight their core values, we have to define their purpose. Metadata references data and makes it ***visible***. Visibility, whether we are talking about identification, management (access/permissions), fast recall, or tracking and monitoring, is at the core of metadata; hence building with metadata should emphasize its visibility.

Part 1: Data/Metadata

What answers, information or notification do students want to make visible and highlight by bringing it to the physical environment?

1. Determine a platform. The platform will inherently create boundaries as to what data is available.

2. Determine what data/metadata to use and how it relates to what students care about, their online identity, what they want to track, what others can track. This is where students start to think about what data is relevant to them and what they would like to showcase.

Socialwave.io (https://mal2333.github.io/IoT/):

- What does data look like?
- Create the digital workflow (zapier + adafruit)

Engage

- In order to introduce the tools and the activity, we discuss the motivations behind social media platforms and what types of data are visible to us.
- We ask students to describe and organize the data they see.
- We want to bring students' attention to keys, values, and entries, although there is no need to mention the technical terms.
- We also listen to learn about, and informally pre-assess, their use of ethical knowledge regarding data management and collection.

Explore

In the explore stage, we use hands-on exploration to build beginning-level knowledge about data retrieval. We aim for students to construct a basic understanding of data sharing between platforms, permissions given to said platforms in terms of passwords, keys, usernames. The focus is on students using prior knowledge of social media platforms and translating their current knowledge of aggregated data into a visual representation. This activity is situated in a low stakes environment with the engaging and relevant subject matter of social media.

Part 2: Giving it meaning

Students will impart meaning to the data, tying it back to a context, a lived experience. Students will correlate the information itself to what it means to them, and as they iterate through the cycle of platform selection (and going through the metadata), they will identify their 'passion project.' In order to decide what is meaningful, they will have to dig deeper through what is available and relate it to their lives. They will build a better understanding of the data cycles and transfers between platforms.

Socialwave.io (https://mal2333.github.io/IoT/):

- What does data look like?
- Create the digital workflow (zapier + adafruit) - iteration

Engage

- We ask students to discuss the meaning behind the metadata they decide to represent.
- We want to bring students' attention to the amount of data that is collected as they weed through and locate what is interesting, personal, and meaningful. By changing platforms, they will notice what information is 'universal,' what is more specific to a platform, ponder the reasons behind those decisions (commercial, political…), and the derived privacy concerns.
- We also listen to learn about students' relationships with social media platforms and engagement. In our design, we decided against a static census of the platform, as it evolves so quickly among young people and is difficult to predict. Instead, we let students be experts and teach us affordances they look for on a platform.

Note: as youth finds inspiration to act in the world via their peers, vibrant digital exchange around seemingly non-political issues can be a gateway to civic life participation. We have to be mindful about what looks like creating and sharing humorous content, for example, as trivial as it is an inherent part of communication.

Explore
In the explore stage, we use an iterative process to try out many platforms and get comfortable with the amount and type of data gathered. Although foreign at first glance, repetition will help students construct a bridge between see/unseen data and their lives. Learners work together to negotiate each phase of the process, including selecting relevant data, suggesting an idea to focus on, and developing a visual representation. Translating the data into a 'story' is a vital part of this activity. Students will start to make critical decisions that will affect their construction in part 3: the type of engagement, notification they want to pursue, and how this translates in the physical world.

Part 3: Embodying the meaning
Students will make their data/metadata visible, embodied, and physical. What does data look like in the physical world? Can we give that meaning a physical representation?
Socialwave.io (https://mal2333.github.io/IoT/):

- Material
- Create the physical signal (hardware, software)
- Paper artifact

Teachers will decide what scaffolds to put in place, dependent on their students' prior knowledge for the project to be easy enough to implement and engage students in complexifying their design. By designing for selective exposure, teachers will decide based on their learning goals if electronics are needed or if advanced coding and software installation are. All materials to scaffold are available at socialwave.io and can be mixed and matched by the facilitators.

Engage
"The data, _____ tells the story of _____ because_____."

- We ask students to truly think and reconsider what data implies, whom it includes, and who is excluded. By projecting their selected data to the physical world, they need to think about what information means online and offline.
- We want to bring students' attention to the narratives we can impart on data and be mindful of their impact. What data should be collected, shared, made public? Should we have a choice, or do we have to relinquish privacy when we get online?

Explore
We used hands-on exploration to build knowledge and bridge physical computing with abstract metadata. We aimed for students to construct new knowledge and apply it in productive ways to transform their reality. Students tell a data-driven story with their paper artifacts, and their stories are built through time and physical space. The material chosen (paper) highlights the exploratory nature, and the ephemerality matches the nature of a social media conversation, with the electronics used as the backbone for the stories.

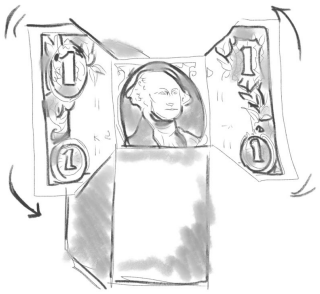
Going further
How might information be spread effectively through your existing social networks?
How can we use these connections to promote advocacy efforts?
How does data fare when out or in context?

Possible pathways

Trump Roar

Platform	Twitter	
Data collected	triggers at new twitter posts of @realDonaldTrump	
Associated meaning	formalized news of public figures, physicality of memes tied to humor and ridicule, amplification of real-life issues on social media, free expression online and offline	

Artifact	President Trump opening and closing his mouth when a tweet is published. A political statement in regards to LBGT rights and republicans' agenda. Servo moving back and forth three times.	`void handleMessage(AdafruitIO_Data *data) {`
		`  Serial.println("Trump tweet");`
		`  for(int i = 0; i<3 ; i++) {`
		`  servo.write(90);`
		`  delay(500);`
		`  servo.write(0);`
		`  delay(500);`
		`  }`
		`}`

Ka-Ching		
Platform	Instagram	
Data collected	triggers at new likes on my feed	
Associated meaning	advertising, sponsored post, influencers, strengthening teenagers' digital literacy skills	

Artifact	$1 bow tie shaking back and forth (+sound output) Servo moving back and forth 3 times (+ speaker)	`void handleMessage(AdafruitIO_Data *data) {`
		`  Serial.println("Like +$1");`
		`  for(int i = 0; i<3 ; i++) {`
		`  servo.write(45);`
		`  delay(500);`
		`  servo.write(0);`
		`  delay(500);`
		`  }`
		`}`

Critique of the Design

In designing any experience, I am a big proponent of tinkering, and I believe planning and tinkering go hand in hand depending on which part of the process students are in. Although I struggled to develop this activity for tinkerability, I purposely designed opportunities for experimentation (from platform selection, testing data, sense-making, revising, and adapting iteratively) to better match the students' desired interpretation in the physical world. However, setting boundaries to 'passion projects' is essential, and although I encourage users to design solutions for a problem they are personally invested in, I am guiding the design relative to material and platforms used. The liberties come from the data and metadata themselves, which are at the core of our educational goals. The activity:

1. Has “low floors, high ceilings, wide walls.” Although targeted at students with some experience with microcontrollers, I provide chunks of code and ground the experience in students’ prior knowledge of social media platforms to counter disengagement. The data exchanges are scaffolded via Zapier, and allow for early success while letting students decide which data they relate to most.
2. Delivers immediate feedback. Most automation platforms allow for quick experiments and quick results, and due to the nature of online communication, the time between making a change or a request and seeing its effect is very short. We are taking full advantage of the rapidity of computation.
3. Allows to watch what happens, hence backgrounding the API requests and using Zapier. On the physical side, Arduino is opaque to the internal properties, but it was a challenge finding a wifi-enabled microcontroller that allows for tinkerability. My first iteration was with a microbit, but it relies on bluetooth BLE via UART connected to MQTT to communicate. Although I have looked it up extensively, it is very foreign to me and not transparent for students. Students have prior knowledge of Wi-Fi signals and will be able to visualize the transfer of data from one device to another.
4. Allows students to get started easily. The components do not require any wiring on a breadboard, and I supplied the setup code. To support fluid experimentation, I designed this curriculum to minimize the setup process as much as possible, and in the facilitation, educators can streamline this even further. Regarding the physical connections, I chose a microcontroller with headers, male/female wires, and servo/neopixels to allow for quick and easy connections. The wires are color-coded; they are easy to use to test different connections rapidly. Ideally, when it comes to the programming language, I wish a higher arduino based language was available (e.g., Chibitronic’s chipchip platform). To counter the syntax’s complexity, I provide blocks of code to be plugged directly into the function, and I separated the code into multiple files to “hide” some of the complexity.
5. Enables students to explore a diverse array of possibilities. In choosing paper as the medium to build with, the physical representation of the data is open-ended. Although we would love for students to ponder their civic engagement when it comes to the internet of things, the activity itself lets students explore a variety of genres. How they want to represent that data and what meaning they give it is up to them. The theme is broad enough to give everyone the freedom to work on projects they care about, which matches their aesthetics.

Conclusion

“Innovation and ICT must be harnessed to strengthen education systems, disseminate knowledge, provide access to information, promote quality and effective learning, and deliver services more efficiently” (Grizzle et al., 2013). Educators must be at the forefront of the Digital Literacy movement, sustaining and renewing the knowledge of successive generations as they have always done. However, data literacy is more than the ability to read. It means being able to understand and decipher the truth of what we read. It applies not only to the access of information but also to critically evaluate and understand that information whether the data is visible or not. By assessing the data collected, we can correlate it to the underlying political and social streams. This enables students to consider their social structures and environment and empowers them to take action that can lead to change and debate.

Digital literacy should be taught with a creative and social purpose, and we should expand our repertoire of approaches. Whether for this project or more broadly speaking, more work remains. Nevertheless, by starting to engage learners with hands-on, creative activities that build their capacity and

engagement through meaningful projects, we are developing their competency and confidence. Next would be to ponder how this design can be part of a larger developmental trajectory?

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