MISSING EXPERIENCES IN EDUCATION

REPAIRING THE SPECIALIZATION OF TECHNOLOGY

A Statement of Topics
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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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As more scientific discoveries are made and technological processes become more complicated, the breadth of information required to facilitate those endeavors grows exponentially. Specialization into very specific fields is necessary to effectively maintain and enhance the infrastructure of communication networks, energy production and distribution, and other crucial processes that work on a global scale. However, as specialization increases, so does the perceived independence of these technologies. Lawyers, judges, and politicians will become thoroughly familiar with law, rhetoric, and precedent, but will have little understanding of the technological complexity of modern systems that impact the lives of millions. This lack of technological literacy becomes problematic when politicians and citizens alike fail to understand the extent of technological problems like human-caused climate change or understanding the efficacy of vaccinations.

How can society properly teach technological literacy when its scope continues to grow into more complex fields? The most crucial aspect of instilling technological literacy in citizens is to ensure that people are invested in knowing more about the technological underpinnings of society. People should want to investigate complex issues, and should have the skills required to do so. It should be a lifelong endeavor and should therefore be taught to students at a young age. As children learn about the world, they must also learn the importance technology plays in it. If done properly, students will be invested in understanding how technology can affect society while still specializing in other fields later in their lives. Educational spaces that do this already exist. CodeVA, for example, is an organization whose sole purpose is to educate young students about various forms of technology and how they can be used. It tries to connect to students so that they may find an intrinsic drive to create and innovate, all while learning about the subject material and understanding how it works. This paper will discuss the effectiveness of CodeVA's educational style in the Technical Discussion and how it can be used to promote technological literacy in the STS Discussion.

MISSING EXPERIENCES IN EDUCATION

The information that people internalize and remember is heavily influenced by having a direct experience with it. A student who plays an instrument will remember much more from a lecture on musical theory than one who does not. The student who plays an instrument will mentally play with the ideas presented in lecture, and will feel inclined to test them out on the instrument later. By having experiences related to the topic at hand, one can relate these experiences to the new ideas presented and experiment with them rather than passing it off as another fact. Experiential learning is an effective tool for cultivating invested students who have a strong desire to understand the subjects they are taught. CodeVA, a non-profit organization based in the city of Richmond, emphasizes the use of hands-on learning to teach elementary and middle school students. Some of its students come from paying parents, but many also come from local community-based organizations that are meant to uplift inner city children. To compare CodeVA's methods of teaching to a more formal, higher-level setting, this discussion will also investigate the teaching styles of the class Human Computer Interactions taught by Panagiotis Apostolellis at the University of Virginia (UVA). CodeVA has two very important aspects that produce an effective learning environment for its students that will be explored in the technical discussion.

First, CodeVA effectively cultivates a creative space in which its students can learn. These creative spaces are marked by experiential learning through hands-on-projects and the acceptance of failure. By having the entire process of learning centered around the student's individualized project, students have more control over pursuing specific topics that fascinate them. Having a tangible project gives the student something to experiment with mentally and physically while being taught new information. Conversely, when a student wants to try something new in their project but does not have the means to materialize their idea, a perfect teaching moment presents itself with ears ready to listen. For example, in a week-long class about game making, students were tasked with creating their own game that they would work on throughout the week. After making a controllable character, one student wanted to create an enemy that would move up and down to block the player, but did not know how to make it happen repeatedly. This was a great opportunity to teach the student about "while-loops," one of the most important building blocks to programming and coding logic. Suddenly, the student had a new tool to apply to other ideas she might have. More importantly, she had hands-on experience with knowing when to solve a problem with a "while-loop" and how to apply it. This is generally the learning experience students will have when making their games throughout the week. What is very effective about project-based teaching is that students have a concrete artifact to take home with them. They gain an entire learning experience that can remind them of the problem solving they went through. Students create something they can have pride in, that they can show to their friends and families.

The entire idea of project focused learning would be moot, however, if students did not feel comfortable trying to pursue their own ideas. This hesitancy can come from fear of failure. What CodeVA does effectively is display a low stakes environment to its students. Designing an entire game can feel daunting to students, so if a teacher sees a student struggling to commit to something, teachers will ask the students for ideas that they might have. In this encounter, teachers are actively listening to the students, and will encourage ideas that they may have as well as giving them a good place to start to realize their ideas. Fortunately, the structure of CodeVA's classes gives teachers the time and flexibility to approach students individually and give each student support and encouragement.

Human Computer Interactions models the aforementioned attributes of a creative space fairly well. The entire semester is mostly concentrated around a group project where the goal is to design a specific product to assist a specific societal function or group such as transportation or educators. Panagiotis Apostolellis, the professor, states in his syllabus, "we will be following a rigorous software design process in order to design-prototype-evaluate (in groups) some interactive product or system that is useful, effective, and a pleasure to use," (Apostolellis, 2021). The class itself is a mix between traditional lecture and activities focused on practicing the material taught in the lecture. Groups are left on their own to complete the project outside of class. This course provides an alternative to the model set up by CodeVA to better suit the needs of a college level curriculum. While the education of students is still centered around one project, HCI still chooses to incorporate the traditional lecture style that is present in most other college and high school level courses. It does so quite effectively, as the in-class activities are closely related to the topics taught in lecture, and students work in the same groups that they are in for the main project. This is a crucial aspect, as it requires active engagement from the students and allows them to practice aspects of the design process as a group (Simpson, Solms, p. 17, 2018). Apostolellis's expectation is that students will have practiced these skills in class, so that they can later use them outside of class for their projects.

While experiential learning is a more effective way of teaching and preparing students for the engineering world (Simpson, Solms, p. 17), it still does not take full advantage of the principle of having a project-based course. The lecture and activities in class take the focus away from the project, and students compartmentalize the in-class material with the projects they work on outside of class. This is where HCI can take influence from CodeVA. With CodeVA, while there might be smaller activities within the week, the main focus is almost always around the greater project directly. The activities related to the lectures for HCI require the students to read through an example scenario and create a model, analysis, or new design based on the specifics of the activity. These activities and their scenarios can easily be replaced by the students' own project which would create a closer coupling of the lecture and project. When attending lectures, students should be thinking about how the concepts apply to their project. By having students work on their project immediately after new material is taught to them, they will already be in the appropriate mindset for testing and experimenting. Like CodeVA, this will also provide an environment where the students can directly ask TAs and the teacher questions for their project instead of a made-up scenario. The TAs and teachers can then read student's body language to figure out why they are struggling in trying to relate the lectures to their projects.

The teacher is the most important component in making a proper creative space. Aside from knowing the material, an effective teacher is a role model for their students. While this is a subjective quality that varies depending on the kind of teacher, there are ways of designing how the material is taught that lends itself to role-model behavior. A maker named David Lang, who is the CEO of a community DIY driven company named OpenROV for ocean exploration, wrote a book called Zero to Maker ("David Lang: Maker", 2013). Here he explores the importance of having a "maker" mindset, its role in communities, and how to teach younger generations the importance of making and creating as a way of learning through educational systems. He delves into this last concept in a chapter titled "Making more Makers," by analyzing maker spaces and project based educational environments similar to CodeVA. What he found was that students who excelled at working on projects coming into the programs "had little to do with experience or education level, but that everyone who finished the project had some sort of role model who had shown them the joy of making" (Lang, 2017, paragraph 12).

It is not sufficient to only have a lecturer. This does not produce students who care about what they are making. While working with students, teachers at CodeVA would be actively working on their own version of the project alongside the students. This way, students can see the teacher's creativity in real time. The teacher can use their own example to evolve and adapt to what students are most interested in. This class structure allows teachers to slip into a role model position able to show their students the joy of making. If the professor of HCI worked on his own project in class as a live demonstration, students could see the problem solving process of an experienced teacher. This would allow students to pick up on small nuances of designing that might have been missed from a straight lecture.

Learning does not happen passively. Students internalize new information far better when they are engaged with the subject material and educational systems should be constructed to reflect this. Lecture centered teaching persists in college to accommodate for the amount of content courses need to cover, but this does not ensure that students are learning from it. Human Computer Interactions takes an important step in the right direction with its project based learning. The class detracts from its efficacy, however, by separating the teacher and lectures in-class from the group work on the projects out of class. The separation does not allow for an effective creative space within the classroom as the class structure discourages students from connecting the lecture with their projects. Apostolellis also removes himself from the students' creative process by having them work on the project outside of class. He is unable to interact with students while they are working as a teacher would at CodeVA. As a result, the burden is on the student to get feedback from Apostolellis and the TAs before submitting parts of their project for grading. Fully experiential learning environments exist in organizations like CodeVA. Students who go through these programs learn a lot about problem solving, working with technology, but most importantly have an enjoyable experience making projects they are proud of to take home. If the goal of courses like HCI is not only to teach students, but to instill a passion for the subject material, then the class could be entirely invested in the students' experience and making sure they feel passionate about their creations throughout the course.

REPAIRING THE SPECIALIZATION OF TECHNOLOGY

The rate at which American society can responsibly adopt new technology is outpaced by rate of technological innovation. Politicians often have difficulty regulating technology constructively, either because they are from an older generation, or their work experience and education was focused on rhetoric, history, and law. Legislators need to be quickly caught up by advisors when addressing problematic technologies and how it negatively affects their constituents. Technological literacy empowers legislators and citizens to engage in conversations about technological innovation, and determine healthy and productive directions to invest resources into. It will require the attention and efforts of all American to reign in the parasitic growth of technologies like fossil fuels and social media algorithms. The STS thesis discussion will examine the current state of politics in how it attempts to protect American citizens, as well as how to promote technological literacy as a way to improve how society handles technological problems. This prospectus will use the Diffusion of Innovations Framework to examine a case study of the US Senates recent attempts to protect teenagers from social media.

Technological Illiteracy undermines the ability of legislators to promote the health and safety of their constituents. The growth of Facebook provides an example of how the United States legislative body responds to societal concerns of emerging innovations like social media. At a Senate subcommittee hearing In the Fall of 2021, Senator Blumenthal brought to Congress the issue of social media accounts on the health of young teenagers. The hearing was directed at Facebook in an ongoing effort to hold Big Tech companies liable for the health effects their products have on their users. In the hearing Blumenthal asked “Will you commit to ending Finsta?” in reference to secondary Instagram accounts teenagers often make in an attempt to hide themselves online from their parents. In an NPR article, the author Alana Wise examines how Congress attempts to approach technological problems like this and how it's perceived by the media. While Blumenthal seemed to understand what a "Finsta" account was and its effects on teenagers' mental health, he was not familiar enough with it to properly communicate the issue (Wise, 2021, para. 5). His poorly worded question was quickly taken out of context and spread on the internet to show how out of touch Congress is with modern technology (Wise, 2021, para. 6). The media's perception of the incident was concerned with making memes of how out of touch Congress seems to be. As a result, the original issue of trying to protect the health of teenagers was quickly overlooked by the greater public. Sarah Wise quotes Senator Josh Hawley, "These Big Tech monopolies know exactly how addictive and manipulative their products are but they're content to rake in billions by exploiting children" (Wise, 2021, para. 26). Though Congress did have the wherewithal to bring Facebook to a hearing on the issue of children's mental health, it occurred after years of social media use by teenagers. When Congress finally attempted to reign in the tech giant, its genuine attempt to tackle a growing issue resulted in a circulation of jokes and memes on the internet due to the technological illiteracy of senators like Blumenthal.

To help understand how and when groups like legislators react to technology, it is important to understand the Diffusion of Innovation Theory popularized by E.M. Rogers in 1962. The theory provides a model for how innovations are introduced and accepted by different social groups. Figure 1 below depicts the various groups involved in the diffusion of innovation with Facebook mapped to it as an example. It begins with the innovators on the left of the figure, a small group who develops a new innovation. If it is promising enough, it will then be adopted by early adopters, a slightly larger subset of the population. The early adopters are quickly made aware of the innovation, and are often social leaders or their opinions have influence over the greater public. Next, come the early majority, who take longer to become aware of and accept an innovation, but are easily influenced to accept and rationalize new ideas. The late majority take much longer to accept change and hold a more reserved view of the benefit of technologies. The main drive for the late majority accepting an innovation is peer pressure. The last group are the laggards who tend to be very skeptical, very traditional, and resist adopting a new technology as long as possible.

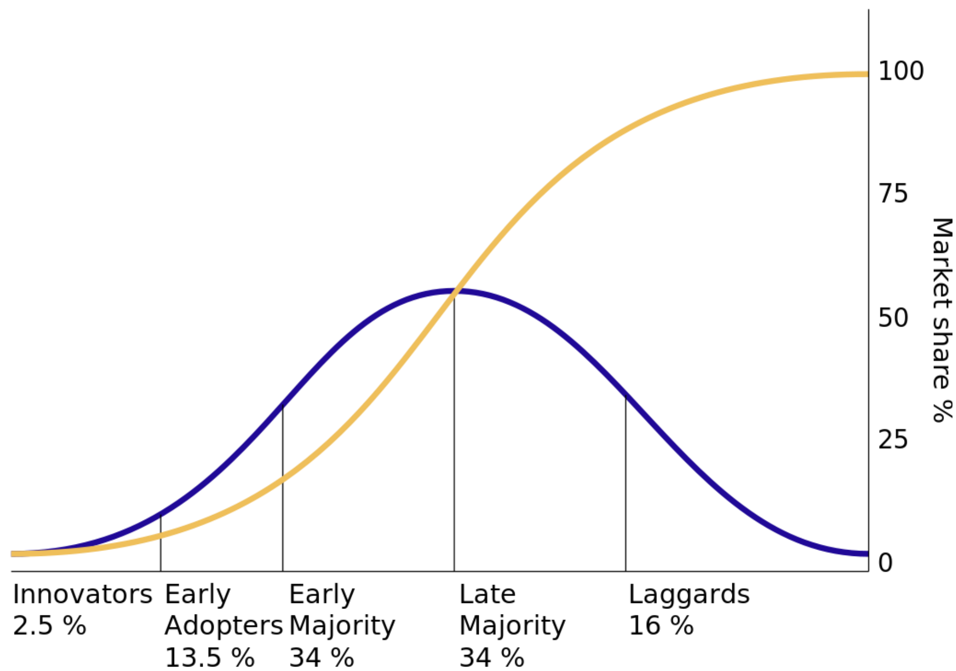

Figure 1: E.M. Rogers' diffusion of innovations model. This figure shows how various groups accept an innovation with varying propensity to adopt under the blue curve. As more groups accept a technology, the market share increases until it reaches a saturation point (Edward M. Rogers 1962).

It is not until an innovation reaches the late majority, when multiple studies have been conducted and the effects of an innovation are clear, that politicians even begin to address pressing issues related to an innovation. In the example of Facebook, the company was able to develop its social media platforms for about a decade since its start in 2004. It was not until 2018, when Mark Zuckerberg, CEO of Facebook, was called to a Congressional hearing, that the company was first faced with significant legislative opposition. Figure 2 below shows an approximate timeline of Facebook's diffusion into the American population. It depicts the time it took for Congress to begin responding to privacy and mental health concerns over the company's lifespan. Since it began, the company itself is the first to see the results of its data from users, and are able to use it to make their platform more profitable. In 2018, around 85% of American teenagers said they used Facebook and 72% said they used Instagram according to data compiled by the Pew Research Center (Gramlich, 2021). A deeper breakdown in age demographics can be seen in Figure 3 indicating significantly higher percentages of young populations using social media platforms. For each social media application, young users most consistently use these applications, most notably with Snapchat and Instagram. The high percentage of young Americans using social media has a strong effect on how the platforms are designed and marketed. The platforms will continue to shape their content around these young reliable groups. It was not until 2020 that a bill was introduced with the Kids Internet Design and Safety Act to try and make social media platforms safe for teenagers (116th Congress, 2020). The Diffusion of the Innovations model applied to technologies like Facebook shows at what point legislators become aware of issues they cause in society and when they try to propose legislation to regulate those technologies. It points out how these legislative bodies tend to be reactionary, and tend to control damage after it has occurred to a significant portion of the population, and the technology has become integrated into society. Problems must be resolved early if technology is to be used effectively and safely such that it benefits society more than it harms. In order to achieve this, the public should be invested in approaching new innovations with thoughtful conversations, and by conducting research to empirically point out issues. Teaching technological literacy to people will allow more citizens to take part in these conversations and point out problematic technologies before they become too ingrained into society like in the example with Facebook.

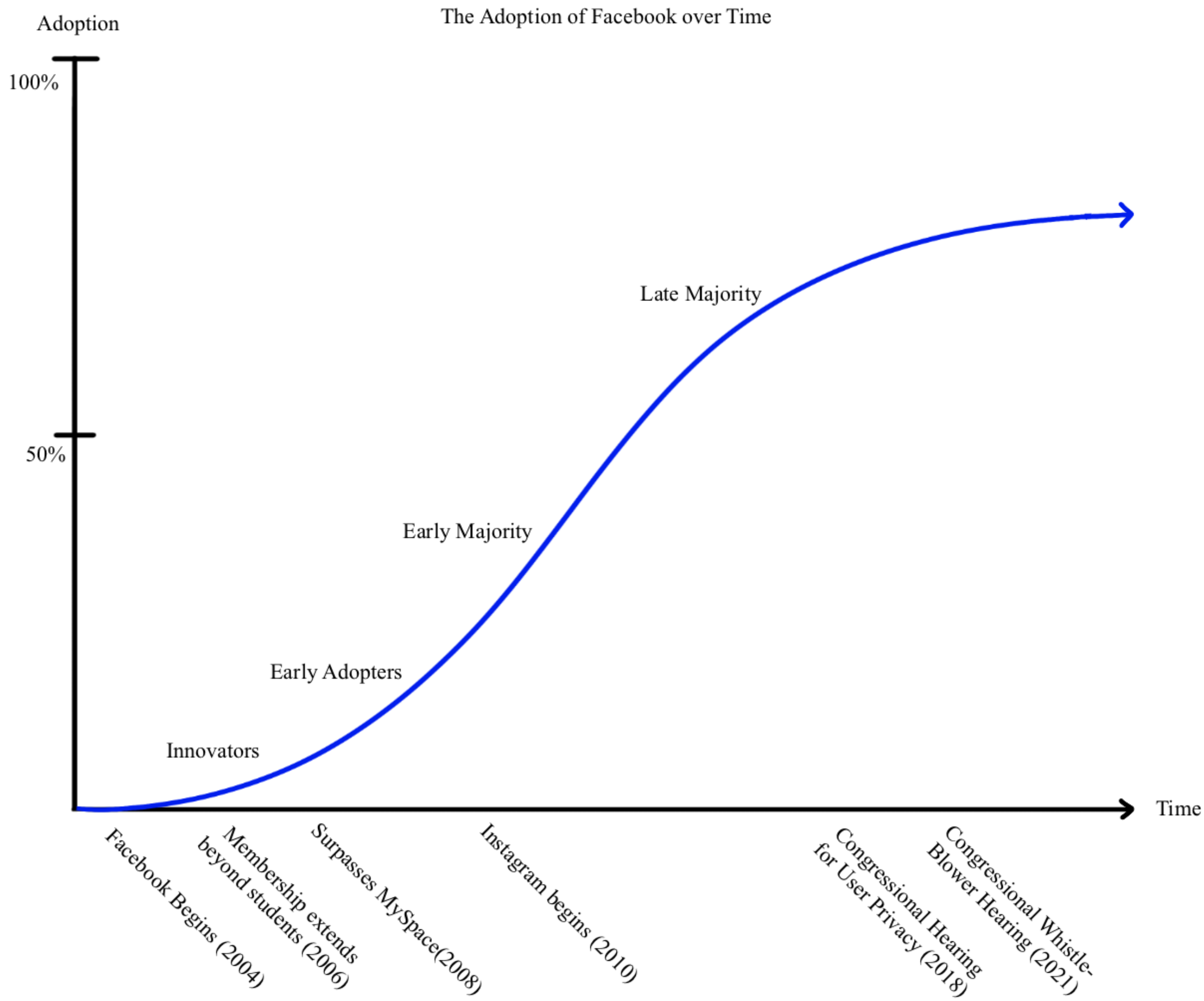

Figure 2: Approximation of the diffusion of Facebook through the U.S. Population. Several important moments in Facebook's history are also recorded. (Alcaine, 2021).

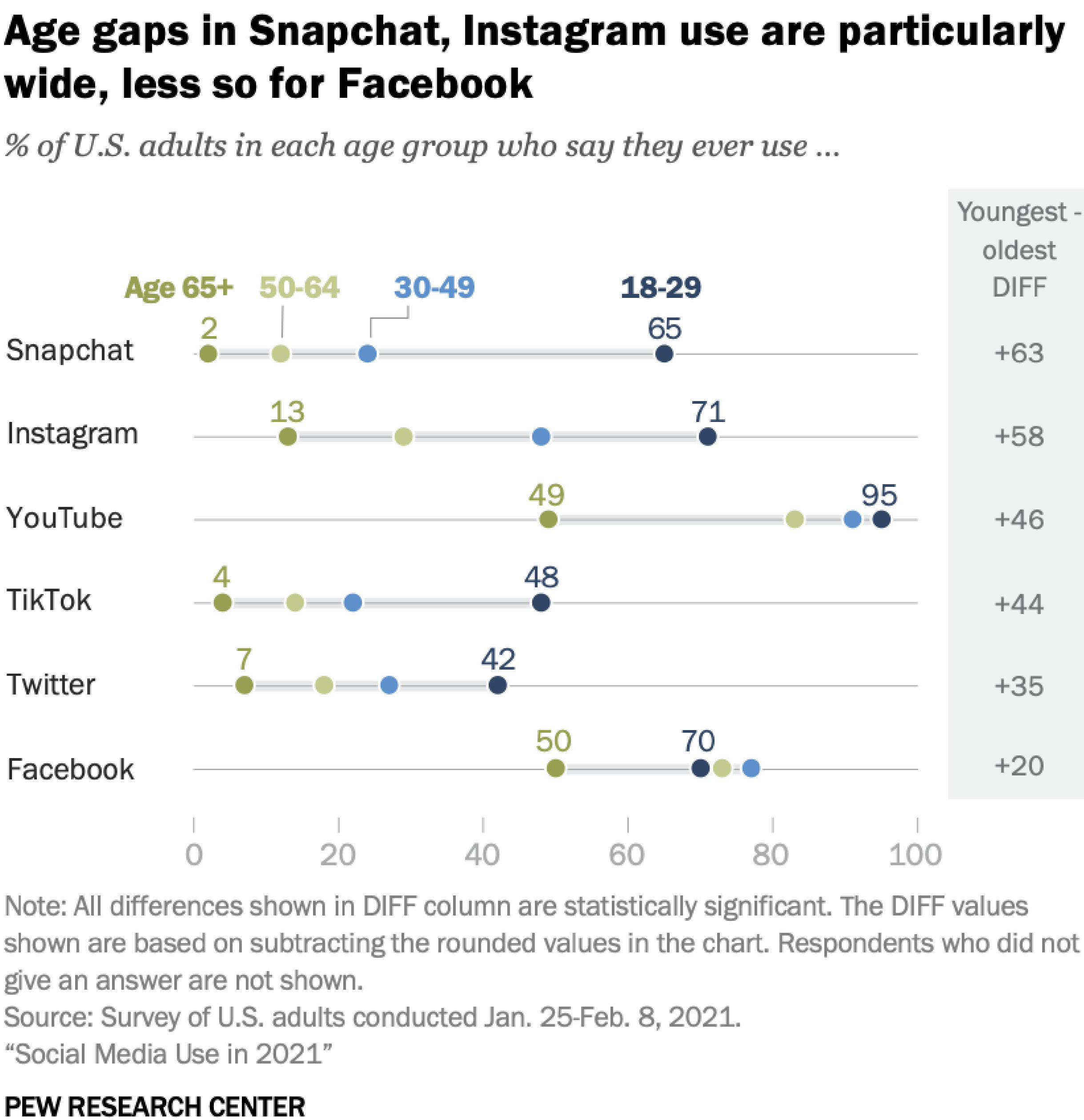

Figure 3: Age breakdown of users for several social media platforms. This diagram is primarily meant to show the age gaps between different user groups on different platforms. (Pew Research Center, 2021).

Technology today is more accessible than ever. Most families in America have smart-phones or computers such that young Millennials and Gen-Z kids are growing up using these devices daily. This basic understanding of how to use these tools can be seen as technological literacy, however, George Bugliarello argues that technological literacy should extend to knowing how the tools and technologies were created, and how they affect society. George Bugliarello was a multidisciplinary engineer who became president of the Polytechnic Institute of New York University, and was awarded the Huber Civil Engineering Research Prize of the American Society of Civil Engineers in 1967 (Juran & Falcocchio, 2011). Bugliarello argues that the broader dimension of technological literacy in citizens is crucial to the health of our democracy. Otherwise, people have "unrealistic expectations about technology, excessive fear of technology, and inability to participate intelligently in the discussion" (Bugliarello, 2000, p. 83). The role of technology in public schooling today is left to the wayside in favor of traditional sciences and liberal arts classes like social studies. The two are in separate spheres, and while science and math lends itself to more technical studies, it does not make an effort to relate to society. The study of technology inherently lends itself to relating how artifacts affect people in terms of risk, safety, and trade-offs (Bugliarello, 2000, p. 84). Schools need to shift their focus toward technology. Not only does it encourage a cross-disciplinary synthesis of students' courses, but it allows students to practice discussing sociotechnical issues and their roles in them.

CodeVA understands that getting students used to interacting with and exploring technology is invaluable for their growth. As technology continues to grow in complexity, it is crucial that younger generations are prepared to meet the challenge in order to be successful. CodeVA's courses cover a wide range of technologies, and in each class, it tries to relate the projects students work on to relevant real-world topics. For example, in a course centered around the integration of technology with clothing and fabrics called E-Textiles, students are shown recent advancements in the field like 3-D printed dresses or hidden touch sensors in clothing that interact with smart devices. Students are also asked to think of their own ideas of how to integrate technology into clothing. The main goal of the class is to explore simple circuitry, and how conductive thread can be used to sew lights into fabric. These students are given important life skills like sewing, as well as given foundational knowledge of a fairly complicated field in technology. Later in life, this student will have direct introductory experience with the various topics CodeVA has taught them, and will feel less daunted by the technological fields when they inevitably encounter them in the future. More importantly they will be equipped with basic skills to explore deeper into the topics if they so choose.

Producing technologically literate citizens begins with teaching technological literacy from a young age. Students shown how technology affects individuals and society as a whole will be able to take part in technological discussions as they transition into adults. As such they will be able to better participate with their environment and can bring about change through an understanding of how technology influences their surroundings. Organizations like CodeVA provide examples of how to integrate technology with education in a way that creates excitement and passion in their students. Through its experiential learning students will be prepared to direct technology in modern society before it becomes problematic and too deeply ingrained in the habits of people. In the diffusion of innovation model, new ideas can be caught and screened for problematic consequences before it reaches the late majority of the population. Judges and Politicians who understand how technology works will be able to better understand how to direct it in a constructive way, and thus improve society. This STS discussion attempts to highlight the gaps in knowledge of many American citizens and American leaders. By educating people of the interconnectedness between technology and society, Americans can avoid the perils of technological determinism and thoughtless innovation.

WHAT CODEVA CAN DO FOR FUTURE CITIZENS

In the educational pipeline, students take math, science, humanities, and arts courses. In standard educational models, students can feel a disconnection in one subject to another. As students begin to specialize into specific fields at higher level education, the importance of other realms of education begin to feel less important than the students' intended major. Some schools might find classes like Science, Technology & Society that begin to bridge those gaps, however this only tends to happen much later in a student's educational path. If technology is focused on in the educational system, the walls between the different classes students take begin to fall away. Most technologies cannot be taught without understanding the technical aspect that allows them to function, and just as importantly, those technologies cannot be taught without understanding their history and how it continues to affect society. Not only do the technical and social aspects feel connected, but students also begin to understand the connection between their education and the real world. Through experiential learning, students are asked to think about what they can add to the topic, and how it will be received by their peers. The connection between technology and society is experienced by the student and thus feels far more tangible. This will have a lasting impact and will create a technologically literate society when these students become leaders in the future.

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