Creating a Vacuum Thermoformer Designed to Help Fabricate a

Powered Air Purifying Respirator for Children

(Technical Paper)

School Closing's Disproportionate Effect on Low-Income Communities

(STS Research Paper)

A Research Paper Submitted to the

Faculty of the School of Engineering and Applied Science
University of Virginia - Charlottesville, Virginia

In Partial Fulfillment of the Requirements for the Degree
Bachelor of Science, School of Engineering

Jack Herrmann
Spring 2021

Technical Project Team Members
Noah Rempfer
Jacob St. Martin
Ryan Gibisier
Dale Midkiff

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

Signature Jack Herrmann Date 10 May 2021
Jack Herrmann

Approved Date 10 May 2021
Richard Jacques, Ph.D. Department of Engineering and Society

Technical Advisor: Gavin Garner, Department of Mechanical Engineering

Introduction

General Research Problem

How can technology alleviate the disproportionate effect of COVID-19 on low-income and minority communities? With an estimated death toll in the United States of 506,834 and rising, lost jobs, and shut down cities, the coronavirus has caused an unbelievable amount of pain around the world (CDC COVID Tracker, 2021). This pain is felt the most by the low-income and minority communities the virus targets. If the virus does not go away, the gap between these low-income communities and high income communities will only get worse. Current solutions to the coronavirus consist of wearing masks, social distancing, quarantining, shut downs, and more. The present solutions have not solved the problem, cases are still on the rise, loved ones are still being lost. The gap is still growing.

Technical Project Abstract

How can a dual air filtration system allow children to return to school safely during a worldwide pandemic? Long-term gaps from in-person schooling can cause students to forget what they previously learned, similar to the "summer slump". The phenomenon where, after summer break, children forget important concepts learned the year before (The Importance of Reopening, 2020). The longer students are kept from in-person classes the more they will slide down the slump. A solution is needed.

Our team's mechanical engineering solution is a Powered Air Purifying Respirator (PAPR) that filters both inhalation and exhalation, the Clean-19. Alternatives to the Clean-19 are students wearing surgical, cloth, or N-95 masks. For reference, an appropriately worn PAPR has an assigned protection factor (APF) of 1000, while an N-95 mask only has an APF of 10

(Considerations for Optimizing, 2020). With kids only wearing masks, schools will still have to social distance, alter bus routes and reduce the number of days students come to school, in accordance with the CDC guidelines (FAQ for School, 2020). These precautions cost time and money. If we can achieve our goal of creating an inexpensive, made for children dual filtration PAPR, in-person classes can occur. Accessing the internet from home will not be the defining factor of a student's success. The educational gap between low-income and high income students will no longer expand due to COVID-19.

STS Research Paper Abstract

According to the CDC, "Persistent achievement gaps that existed before COVID-19, such as disparities across income levels and races, can worsen and cause serious, hard-to-repair damage to children's education outcomes" (The Importance of Reopening, 2020). Low-income students that kept up during in-person classes will now be left behind with an online curriculum (Beaunoyer, Dupéré, & Guitton, 2020). The closing of schools due to COVID-19 affects low-income and minority communities disproportionately to others.

Literature Review for STS Research

Two main social groups deal with this issue; schools and families. I will analyze how well-funded schools, where most students come from middle to upper income families have adapted to moving online. Looking into how the teachers and schools have been able to include the few low-income students in their curriculum that do not have access to the internet at home. For comparison, I will also look at how under-funded schools altered their courses to be taught at home, along with their success rate at keeping students engaged.

The second social dynamic I will investigate is that of students and their families. Researching how family dynamics changed at home because of coronavirus is a key to

understanding the total effect the virus has in different communities. A parent's ability to work from home, provide food on the table and help a student in need makes all the difference in a student's potential for learning at home.

Methodology for STS Research

To investigate these relationships, I will gather data from government agencies about technology gaps within our society. These gaps include the gap between under-funded schools and well-funded schools and the gap between low-income students and peers at the same school. I will then research if/how these gaps are leading to educational gaps at home because of an online curriculum. Finally, I will explore if there are any policies in place to help close these gaps.

For exploring the family student dynamic, hearing how different families have adapted to online school is most important. To gather this information, I will focus my research on first hand accounts of active online students. Other statistics on technology and food security will be gathered and investigated to fully understand the consequences of online schooling for the low-income communities.

School Closing's Disproportionate Effect on Low-Income Communities

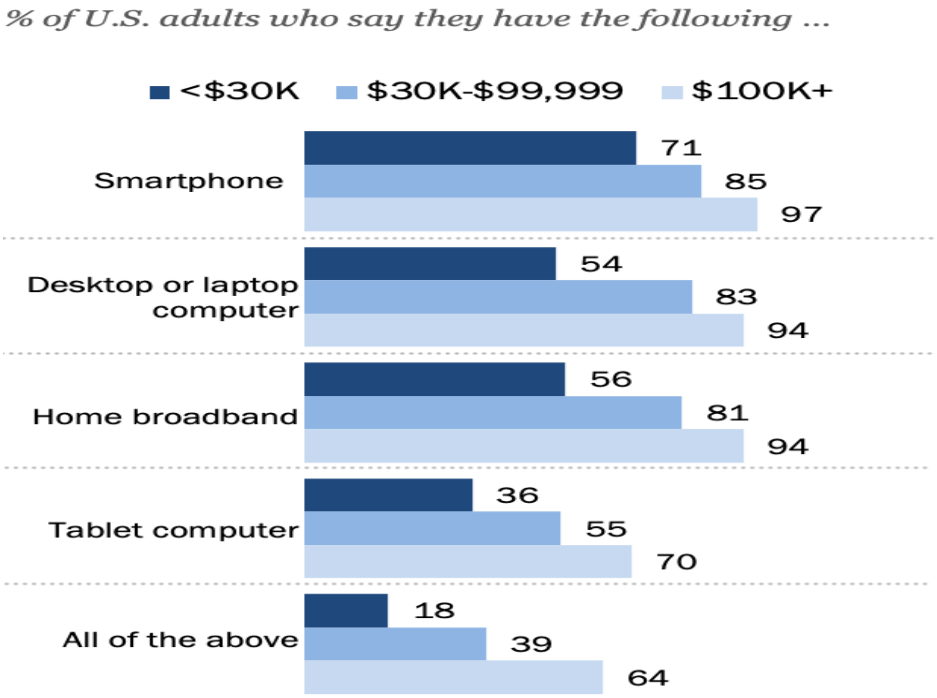
The Technology Gap.

To understand the problem of online schooling, examining the technology gap between the poor and wealthy is vital. As shown in Figure 1, there are large divides in technology accessibility at home between income classes (Anderson & Kumar, 2019). For example, 56% of households earning less than $30,000 a year have broadband internet access in their home. Alternatively, if the household earns over $100 K, there is a 94% chance they have home broadband (Anderson & Kumar, 2019). A 38% difference. The trend is constant with access to

smartphones, desktops, and tablets as well. The largest gap occurs when respondents were asked if they had access to all of the above.

Figure 1

Lower-Income Americans Have Lower Levels of Technology Adoption



Note. Respondents who did not give an answer are not shown

Source. Pew Research Center Survey conducted Jan. 8-Feb. 7, 2019

If the adults do not have access to a computer, the chance their kid does is even lower. Then imagine if they have two, three, or even four children. Supplying each of those kids a computer and a strong broadband connection is too expensive for the family to afford. During these special times, to have access to an Internet device is to have access to education. Those homes without Internet are unable to join class, access homeworks, and communicate with the

school. The transformation of the school's curriculum to move all online leaves the children of these adults behind.

To further understand the challenges of moving low-income students online, it is best to look at people's experiences first hand. The first case we will review is an English teacher in the Bronx, Ms. Stephanie Paz. When the initial transition to online school occurred, more than half of her students did not have access to a computer or internet (Reilly, 2020). The district tried solving the problem by handing out laptops, but the school did not have enough to-go around. She then had to resort to sending out paper-learning materials to those that did not have internet. With these packets, the teacher cannot track a student's real time progress, help the student one on one, or answer questions from the students. The packet is to be completed by the student independently and returned to the teacher for grading.

Other examples exist across the country. A principal, Alyssa Roe, in Brooklyn stating that it took weeks to get 100 children internet ready devices (Reilly, 2020). However, in the neighboring district where her two sons go, they could smoothly transition to online due to a parent donor. The accessibility is unevenly distributed across neighborhoods because one district might benefit from a past contribution from a wealthy family, where another will not (Reilly, 2020).

In contrast to the under-funded schools, wealthy schools have easily moved online. Most students had the resources to access the regular class meetings and assignments. If a few students do not have computers, the district has resources available to loan them a device and even supply a hotspot for the internet. The transition has been relatively smooth. If online class is not up to a wealthy family's standards, they can even buy their way into in-person classes. One example is

the Frederick Gunn School where parents can pay $66,523 for their children to get in-person education (Sullivan, 2020).

Low-income families have been getting subpar education for decades, but the pandemic has widened that gap. Where the gap used to range from larger class sizes to smaller class sizes, it now ranges from no class at all to a premium, in-person class experience. Sunita Kulkarni, a leader in providing quality education to underprivileged kids, states, “Irrespective of race, creed, and gender, education makes it possible for people to stand out as equal with all the other persons from different walks of life” (Balaji, 2020). The pandemic is currently making the inequality of education even worse, thus making it harder for the children in our low-income schools to “stand out as equal” to others in their society.

FOOD

Not only are school closings attacking the education of low-income families, it is also disrupting their food supply. In 2018, the National School Lunch program provided an average of 29.7 million lunches each day (Coleman, 2019). Schools are the low-income family’s lifelines. They rely on the school to keep their children from hunger each day. As schools close, access to those 30 million meals became limited, food insecurity increased, meals were missed. According to Table 1 published by the American Public Health Association, over 1.1 billion meals were missed from the beginning of March to the start of May. (Kinsey, 2020).

Table 1

Weekly and Cummulative Missed Free and Reduced-Price School Meals: United States, March 2-May 1, 2020

Dates	Weekly Meals	Cumulative Meals
March 2–6	36 802	36 802
March 9–13	2 598 526	2 635 328
March 16–20	124 824 223	127 459 551
March 23–27	169 479 514	296 939 064
March 30–April 3	169 619 512	466 558 576
April 6–10	169 619 512	636 178 088
April 13–17	169 619 512	805 797 601
April 20–24	169 619 512	975 417 113
April 27–May 1	169 619 512	1 145 036 625

Efforts have taken place to reestablish pre-COVID meal delivery rates, but families are still being left behind. Most shut down schools have switched from the National School Lunch program to the Summer Food Service Program or the Seamless Summer Option (Coleman, 2019). This switch allows schools to give two meals a day to children under 18. Other initiatives include meal delivery through bus routes, picking up weeks of food in one trip, and other private-public partnerships. However, in order to access these initiatives and get special services, a family needs to fill out a waiver.

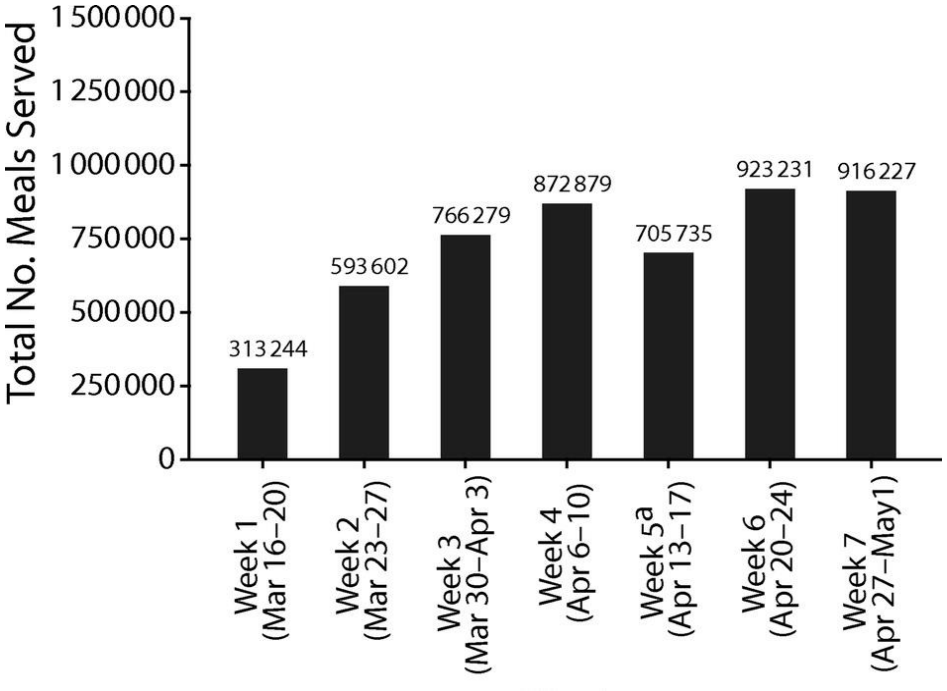
The effectiveness of these policy changes, new programs, and innovative partnerships can be analyzed using Maryland as a case study. When schools shut down, the low-income families in Maryland lost their food supply for their children. Over the weeks the government and private partnerships stepped in to help deliver food to the children. The waivers were sent

out to families, meals were served along bus stop routes, and children received their week's worth of meals in one trip.

As shown in Figure 2, the amount of meals delivered steadily increases as leaders learn how to optimize delivery of meals. The maximum number of meals delivered during the data collection period was 923,231, a 3-fold increase from the beginning of the pandemic. On average before COVID-19 the Maryland school district supplied 2.5 million meals (Kinsey, 2020). That means at the current rate of meal delivery, there are still more than 1.5 million meals not being delivered each week.

Figure 2

Number of Breakfast and Lunch Meals Served per Week During COVID-19 School Closures: Maryland, March 16–May 3, 2020



The solution to the problem, while helpful, is still not getting it done. These schools need more funding for community reach and there needs to be an expansion of Pandemic Electronic

Benefit Transfer (P-EBT) supplements. The increased funding will allow more schools to actively participate in home delivery of meals. In the current climate, schools are worried about securing refunds for new costs of providing the meals such as to-go bags, packaging, and gas. The fear of incurring debt has discouraged schools to participate.

Another solution that would help is expanding P-EBT to all 50 states. Currently, only 20 states allow P-EBT (State Guidance, 2021). If the government expanded the supply of P-EBT, it would grant low-income families $5.86 per child per day (Pandemic Electronic Benefit, 2021) . With these additional funds, parents would be able to provide their children with nutritional meals. With these two improvements, less impoverished children will have to worry about when their next meal will be and can focus more time on school.

In contrast, food security for middle to upper income class students has not changed. They do not rely on schools for food such as lower income families do. Wealthier students can still go to the grocery store and purchase meals for the week. The opening or closing of their school does not dictate if they eat. They do not have to think about when their next meal will be like their less fortunate classmates.

Conclusion

COVID-19 has disproportionately affected the low-income and minority communities in jobs lost, death rates, and infection rates. There needs to be a solution that allows for people of all income levels to achieve equal educational opportunities and access to food during pandemics such as COVID-19. The disruption of the food supply and education has hit these communities the hardest. No internet means no school. No school means no food. Something needs to be put

in place to get all students back on a level playing field. These communities need help and they need it now. The gap is growing faster than ever.

References

Anderson, M., & Kumar, M. (2019, May 7). Digital divide persists even AS lower-income Americans make gains in tech adoption. Retrieved February 22, 2021, from https://www.pewresearch.org/fact-tank/2019/05/07/digital-divide-persists-even-as-lower-i ncome-americans-make-gains-in-tech-adoption/

Balaji, R. (2020, July 06). How a 70-year-old woman is making education affordable for children in Pune. Retrieved February 27, 2021, from https://yourstory.com/socialstory/2020/07/ valley-view-high-school-pune-affordable-education-children

Beaunoyer, E., Dupéré, S., & Guitton, M. J. (2020, October 1). COVID-19 and digital inequalities: Reciprocal impacts and mitigation strategies. Computers In Human Behavior, 111.

Coleman-Jensen, Alisha, Matthew P. Rabbitt, Christian A. Gregory, & Anita Singh. (2019, September). Household Food Security in the United States in 2018, ERR-270, U.S. Department of Agriculture, Economic Research Service.

Considerations for Optimizing the Supply of Powered Air-Purifying Respirators (PAPRs). (2020, April 19). Retrieved October 06, 2020, from https://www.cdc.gov/coronavirus/2019

_____-ncov/hcp/ppe-strategy/powered-air-purifying-respirators-strategy.html

CDC COVID Data Tracker. (2020, October 26). Retrieved October 25, 2020, from https://covid.cdc.gov/covid-data-tracker/#cases_casesinlast7days

Coronavirus Disease 2019 (COVID-19) and Minority Communities. (2020). Retrieved October 01, 2020, from https://phpa.health.maryland.gov/Documents /COVID_minority_health.pdf

Coronavirus Impact on Students and Education Systems. (2020). Retrieved October 01, 2020, from https://naacp.org/coronavirus/coronavirus-impact -on-students-and-education-systems/

FAQ for School Administrators on Reopening Schools. (2020, July 24). Retrieved October 06, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/community /schools-childcare/reopening-schools-faqs.html

Kinsey, E. W., Hecht, A. A., Dunn, C. G., Levi, R., Read, M. A., Smith, C., . . . Hager, E. R. (2020). School closures during COVID-19: Opportunities for innovation in meal service. *American Journal of Public Health, 110*(11), 1635-1643. doi:10.2105/ajph.2020.305875

Pandemic electronic benefit transfer (p-ebt). (2021). Retrieved February 25, 2021, from https://www.dss.virginia.gov/benefit/pebt.cgi

Reilly, K. (2020, March 26). Coronavirus is Exposing Glaring achievement gap for students. Retrieved February 22, 2021, from https://time.com/5810503/coronavirus-achievement-gap-schools/

State guidance on coronavirus pandemic ebt (p-ebt). (2021, February 25). Retrieved February 27, 2021, from https://www.fns.usda.gov/snap/state-guidance-coronavirus-pandemic-ebt-pebt

Sullivan, P. (2020, October 09). Private schools hold new attraction for rich parents. Retrieved February 18, 2021, from https://www.nytimes.com/2020/10/09/your-money /private-schools-wealthy-parents.html

The Importance of Reopening America's Schools this Fall. (2020, July 23). Retrieved October 02, 2020, from https://www.cdc.gov/coronavirus/2019-ncov/community/ schools-childcare/reopening-schools.html