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Understanding Urban Cmputing Equity Policy Issues by Examining Ecological Systems

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Abstract: Urban parents and teachers are aware of computing equity issues in the K-12 schools and their community. The last several years throughout and following the pandemic have provided them with the opportunities to further develop their valuable insights and share them with key policy decision makers. This ecological system study captures their insights and compares them with current policies to reform and innovate urban schools in a large urban school system in Baltimore, Maryland. The results include upgrading the entire computing ecosystem to provide adequate and working devices, reliable Internet connectivity, and computing education content and skills within and beyond the classroom. The continued investment of time and funds devoted to closing the digital divide and responding to the stakeholders is evident in Baltimore City. There is still more work to do, but by examining the ecological system at each level, the policy decision makers can and will continue the forward progress.

Key words: urban education, computing education, ecological system, equity

1. Introduction

The COVID-19 pandemic forced Baltimore City Public Schools (BCPS), an urban public school system, to close schools and offer remote learning opportunities for students in this Mid-Atlantic region in the United States. Students and teachers were sent home and told to limit their physical interactions with others outside of those in their homes. This became more problematic for families who live in this Baltimore City, which is densely populated. For example, the socially distancing guidelines to maintain six feet between people was often not realistic in urban stores. No one could imagine that the pandemic would persist with multiple variants of the virus for over two years. The lessons learned during and then after the pandemic informed education policy changes. This study focuses on the insights from parents and teachers on how to address and solve computing equity policy issues.

The parallels between the complex biological ecosystem research and education research led to a theoretical perspective to study the entire, complex education ecosystem. Based on prior research from human ecology, the education ecosystem approach provides a broader lens to capture the complex lives and interactions of humans with each other, systems, and the environment (Bronfenbrenner, 1989). Such complex education ecosystems

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provide an opportunity to study components and the whole system within the same study. This has been applied to schools in order to study school reform beyond the classroom walls and to construct the interconnectedness and influence of additional factors not previously captured when a study is isolated to the classroom (James et al., 2016). Studies which limit or ignore external classroom influences fail to account for the rich interactions that individuals have on a daily basis. Attending to the various educational settings beyond the classroom enables a more robust analysis of the entire learning ecosystem instead of contributing all of the learning to a single intervention in a single setting (Esteban-Guitart, et al., 2018). This allows for examining how information, knowledge, and skills transfer from one setting to another across the vast and complex education ecosystem.

Each setting, system, organization, or element within an education ecosystem offers unique experiences for ecosystem stakeholders. The levels of the ecosystem need to be studied in order to reveal how transfers occur between spaces and interactions across the system (Bronfenbrenner, 1989, 1994; Hecht & Crowley, 2019). In particular, education policy may reveal how the authority and autonomy over decision-making is navigated by stakeholders, especially teachers, parents, and students. The digital divide for individuals and families within the ecosystem is impacted by each of the system levels (Belluomini, 2014). Prior decades of education research demonstrated that classroom teachers will retain autonomy even within high accountability initiatives in order to best serve the needs of their students (Reyes-Guerra et al., 2014). However, in the open systems of urban school environments, teachers require additional support structures to effectively teach their students who have varying needs (Kraft et al., 2015). Urban school systems often collaborate with other organizations to provide continuous support for teachers and students in the urban education ecosystem. The most successful urban education ecosystem initiatives moved beyond collaborations to include collective impact models (Grossman et al., 2014). The Covid-19 pandemic placed enormous stress on the urban education ecosystem as the boundaries of learning extended beyond the schools during extended remote learning.

The pandemic did not cause a digital divide among urban residents, but it absolutely provided the context to generate more action to begin to close the digital divide. The urban environment is often thought of as a cultural center with technological advancements, which is true for some subgroups within the city (Gilbert, 2010), but this only reinforces the vast digital divide with areas and subgroups in Baltimore who do not have wireline Internet access or Wi-Fi access (Horrigan, 2020). In fact, of the 33 United States cities examined for a 2020 report, Baltimore ranked 29th in wireline broadband adoption. Baltimore contains a fractured urban computing education ecosystem. However, the COVID-19 pandemic thrust these issues into the political arena to fully engage policymakers in conversations of how to address and solve computing education issues.

2. Theoretical Framework

The urban computing education ecosystem is a complex system with multiple levels of interaction. Bronfenbrenner's ecological systems theory (EST) provides the framework to study individuals in context accounting for the variety of setting-level influences which impact the individual in the ecosystem (Bronfenbrenner, 1989, 1994). EST contains the following levels: (1) microsystem (individual), (2) mesosystem (interpersonal), (3) exosystem (community), (4) macrosystem (societal), and (5) chronosystem (timing or stage of life). Each level or subsystem provides insights into the digital divide. For example, at the microsystem level, each individual varies in terms of their age, sex, health, mental health, socioeconomic status, culture, access to digital tools, use of digital tools, connectivity to the Internet, etc. (Belluomini, 2014). The microsystem can be further

examined by categorizing interactions in both the virtual microsystem and the physical microsystem (Navarro & Tudge, 2023). Each additional level layers in even more complexity to study the issues within a level in isolation or combined across levels to better understand the computing education issues. Policies aim to alleviate these issues; however, sometimes, the policies are not sufficient by neglecting issues within another level which impacts implementation in the ecosystem.

This study elevates the parents' and teachers' insights on how to address and solve computing equity policy issues. The overarching research questions motivating this study include:

- Which policies and at which levels of policy implementation impacted the transitions of learning for teachers and students during and after the COVID-19 pandemic?
- Which stakeholders in the urban computing education ecosystem impacted policy implementation?

Stakeholders across the ecosystem benefit from the examination of the digital divide and the policies at the varying levels enacted in the urban computing education ecosystem in order to continue to address needs and solve issues which persist and/or arise.

3. Methodology

The EST requires a deeper dive into the context of each level within the urban computing education ecosystem. A phenomenological approach was used in order to make meaning from the parents' and teachers' experiences, allowing patterns and themes to emerge (Corbin & Strauss, 2008). Policy changes were tracked through meetings, such as the Baltimore City Board of Education and the Maryland State Board of Education, and through media outlets from Baltimore City and Maryland state government offices. During and after the pandemic, surveys and interviews were conducted with Baltimore parents and teachers.

A total of 60 BCPS teachers and 90 parents responded to the survey. Of the 60 teacher respondents, 69% identified themselves as female, 23% identified themselves as male, and 8% preferred not to answer. Demographically the teachers identified themselves as 25% African American or Black, 15% Asian, 47% Caucasian or white, 5% Native American, and 8% other. There was representation of teachers who taught from pre-kindergarten and every grade level through twelfth grade. Of the 90 parent respondents, 78% identified themselves as female, 19% identified themselves as male, and 3% preferred not to specify. Demographically the parents identified themselves as 53% African American or Black, 3% Asian, 36% Caucasian or white, 3% Native American, 3% Hispanic or Latinx and 2% other. There was representation of parents who have students in pre-kindergarten and every grade level through twelfth grade. In-depth interviews were conducted with 4 teachers (3 also had children who attended BCPS) and 4 parents. The teachers who were also parents identified as an African American female, a Black female, and a white male. The other teacher identified as white and non-binary. Two parents identified as African American females and the other two parents identified as Black females. Both the surveys and interviews provided opportunities for parents and teachers to share their experiences.

There were several limitations to this study. Even though the survey was deployed by the research team and supported via IRB by the BCPS, recruitment efforts were difficult. The team sent it out via email and also had paper copies available to community members who preferred paper to the electronic survey. The low responses still provided important insights that informed policies at each ecosystem level. The interviews were carefully selected for a variety of individuals who live in the city and provided in-depth information for specific individuals and the contexts that they navigated.

4. Results

The COVID-19 pandemic forced the BCPS to close schools and provide remote learning opportunities. These opportunities were not equal for all teachers and students. The digital divide with lack of devices, online access, and adequate computing knowledge and skills for teachers and students thrust digital equity issues into the center of policy conversations. Parents and teachers expressed different views on feeling supported from various levels (see Table 1) Most parents felt supported by other parents (81%) their students' teachers (80%), and school-based administrators (71%), and fewer parents felt supported by the superintendent's office (28%) and the central office administrators (21%). Most teachers felt most supported by other teachers (80%), their school-based administrators (59%), and the IT office (49%), and fewer teachers felt supported by the Maryland State Board of Education (18%) and the Maryland State Department of Education (13%).

Table 1 Levels of Support

Support During Remote Learning		
Level	% Parents who felt supported	% of Teachers who felt supported
Teachers	80%	70%
Parents	81%	46%
School-level Administrators	71%	59%
Central Office Administrators	21%	20%
School System Information Technology (IT) Office	40%	49%
BCPS Superintendent's office	28%	24%
Local Board of Education	39%	24%
Non-profits/Community Organizations	39%	39%
Maryland State Board of Education	33%	18%
Maryland State Department of Education	31%	13%

4.1 Microsystem

The full transition to online remote learning for all students was not able to be completely deployed initially. Only 59.3% of City households had a wireline internet service, and gaps persisted with 73.3% of white households with this service when compared with 50.2% of African American households and 46.4% of Hispanic households (Horrigan, 2020). Wireline Internet access is needed to adequately utilize remote learning platforms. Relying solely on mobile devices, such as smartphones, limits some of the functionality of the online learning platforms and is more difficult to create and transfer files. In the City, device acquisition is also an issue particularly with low-income families. Approximately, 80% of the City households with children did not have a desktop or laptop computer, and these households also have an annual income less than $50,000 (Horrigan, 2020). One teacher commented that, "Getting people to realize that many of the problems we are facing during remote learning already existed. The health pandemic merely magnified the poverty level, digital divide, and lack of tech equipment & support that City students were experiencing for decades."

Parents also voiced their concern for their students' lack of learning and engagement while online. One mother expressed her frustration with her son's experience saying, "Number one, I would ensure students are mentally present in class — whether that's a simple requirement that cameras are ON, so teachers can see students' engagement, OR a way to put parental controls on devices so students cannot 'wander' around the Internet. AND,

I promise you, most students are cheating. I mean really, you expect them to take exams with a world of knowledge at their fingertips and no one is there to ensure they aren't cheating? Ugh, I feel like he's learned nearly nothing this year. He literally says at least once a week that he wishes he could have had a gap year."

Parents and teachers worked closely together to troubleshoot issues and did their best to keep students engaged. They often relied on the IT office for technology issues and school-based administrators for resource (laptop, books, supplies, etc.) issues. Teachers were also overwhelmed with the amount of extra planning and professional development time it took to support their students and families.

Moving back into the classroom after the pandemic enabled students and teachers to revert to using devices during the day in school and at night for homework. The digital divide in access at home persisted with Internet speeds being a significant complaint by students and parents.

4.2 Mesosystem

The BCPS provided devices to students, but deployment was not the same at each school. Some schools deployed Chromebooks only to realize that they did not have power chords to send home since they had been charging them with docking stations. One parent pointed out that the high school had not thought about device use increasing during this time. "The high school issues a Chromebook freshman year to be maintained through graduation. Kids keep the Chromebook though severely outdated by then."

The BCPS worked to increase the knowledge and skills of the students and teachers while remote learning, but the gap in computing education skills and knowledge is apparent for both students and teachers. BCPS created and deployed a comprehensive plan to continue learning for all students including the Education and City Television Channels, online learning opportunities, paper-based learning packets, online learning platforms for interaction, and telephone outreach for support (Baltimore City Public Schools, 2020). The need for more support, training, and guidance throughout the COVID-19 remote learning was evident. Information Technology issues regarding how to navigate and use online platforms persisted, but even more importantly, there were gaps in how to use and create technology-based education materials. Teachers and students struggled to keep the remote learning opportunities at an adequate level to demonstrate learning that meets or exceeds traditional classroom outcomes. As one parent noted, "There were a lot of tantrums at our house despite the fact that her teachers were highly engaging and amazing. But we made it through, and she actually learned quite a bit. I would say. It wasn't easy or smooth, but it worked for the most part. Well, the teacher's instructional delivery was very dependable and smooth…. and answered emails ASAP. I felt we were very supported by our teachers and school!"

The increase in usage of devices after the pandemic is promising; however, problems have persisted. Maintenance and software on the devices were problematic during and after the pandemic. Lost, stolen, or broken devices also needed to be replenished at higher rates when students began to take devices to and from school after the pandemic.

4.3 Exosystem

The broader community rallied around the schools to assist as much as possible. A coalition of City organizations grew to over 60 by the summer of 2020. Numerous non-profits, community-based organizations, and higher education institutions worked to assist the citizens including the students and teachers. Shared visions and goals enabled the organization representatives to work together and share the space to further the digital equity cause. Code in the Schools is a non-profit organization which has been working toward digital equity in the

city since 2013. Code in the Schools provides numerous services within the city. During the 2019–2020 school year and while transitioning to online programs, Code in the Schools maintained 15 public school partnerships in the city, refurbished and donated over 600 computers, provided 385 hours of free technology support, provided 540 hours of free online programming to over 7,000 city youth, and hosted 9,215 hours of professional learning for educators (LeGrand, 2020). This is just a sampling of the tremendous support that was provided. One parent expressed gratitude for this organization by stating, "I obtained a laptop from the coding club for him to use to connect to school." Without this device, her child could not participate in remote learning.

This non-profit partnered with other non-profits and the Digital Harbor Foundation to determine a sustainable solution moving through and beyond the pandemic. In the summer of 2020, funding was secured, and a position was advertised for the Digital Equity Coalition (DEC) Manager. DEC was administratively supported by Digital Harbor Foundation, and the manager was hired to coordinate the ongoing planning meetings. The coalition embraced the collective impact model and Theory of Action to grow from emerging to sustaining civic infrastructure (Grossman et al., 2014). DEC includes many parents and grandparents of City school students.

City shifted policy focus as well. In the spring of 2021, Mayor hired the first Chief Data Officer, Broadband and Digital Equity Director for the city (Scott, 2021a). Then, in the fall of 2021, he dedicated $35 million dollars from the American Rescue Plan Act (ARPA) funds to focus on the digital divide in the city (Scott, 2021b). Two years later, the Mayor continued to elevate this work by creating the digital equity fund (Scott, 2023a) and investing close to $1 million dollars which went directly to these organizations that have been dedicated to closing the digital divide in the city (Scot, 2023b). The current city administration is clearly dedicated to narrowing the digital divide with a recent release of a five year plan to address the digital divide (Scott, 2023c). These welcomed changes were advocated for by DEC, the City Teachers' Association, and parent organizations.

4.4 Macrosystem

The Maryland State Superintendent of Schools closed the schools on March 12, 2020 and provided guidance for school systems on how to transition to remote learning, such as suggested schedules, how to maintain food nutrition programs, and how to provide school counseling services (MSDE, 2020). This state is a local control state in which local school system boards of education retain more control over implementation plans. Each school system then set their own plans and submitted them to State Department of Education (SDE). City's plan provided flexibility to accommodate for the lack of devices and Internet access while the system worked within and with external partners to continue to address students' and teachers' needs (Baltimore City Public Schools, 2020).

The State is also examining how to adjust the school day to become more innovative. The Blueprint law calls for tutors to assist in the classrooms (Md. Code, EDUC §5-401). The logistics of this plan and the credentials of the tutors are still being debated, but we found that parents who responded to the survey would also like more in-school tutoring support for their students (29%) and additional time with their teacher (28%). One teacher also suggested that online school options should have "three days of school, one day professional development day, and one day of planning." The concept of shortening the school week has become a reality for some rural schools; for example, Texas, moved to four days of school per week due to teacher shortages after the pandemic (Lopez, 2022). Such a drastic change in the school schedule has not materialized in this State, but advocates are interested in these types of innovative reconfiguration of a traditional school day.

In addition to the education policies, the state focused on changes within the state code. Two bills were

introduced and one emerged to create state level infrastructure to address the digital divide. Governor signed the Digital Connectivity Act of 2021, establishing the Office of Statewide Broadband (OSB) in the Department of Housing and Community Development (Md. Code, HU §6). OSB's mission is to ensure that every State resident has high-quality, affordable broadband Internet service and connects to reliable broadband Internet by December 31, 2026. Funding from both the federal government and state was also provided to support this new office and achieve the mission of broadband to all citizens regardless of the zip code in which they live.

4.5 Chronososystem

The vast range of experiences for both teachers and students from K-12 raised issues of screen and seat time during remote learning. One parent noted, "My kindergartner….had a hard time keeping focused on her 3 hours synchronous work and asynchronous work after that." Screen time has long been an issue for the youngest learners since these students are using devices both in school and at home, and parents are not always informed or working with teachers to find a healthy balance between traditional learning and learning with technology (Alade & Donohue, 2023). An elementary teacher shared, "I'm used to doing lots of hands-on activities with younger children, and it has been hard to keep them engaged on the computer. A high school teacher transitioned quickly saying, "I am fortunate that my subject (computer science) can be taught remotely fairly well." The maturation process and what is expected in different learning environments needs to be considered by policymakers, who listened closely to the parents' and teachers' concerns.

5. Conclusions

Many lessons have been learned throughout this process. The devices used to connect to remote learning, the Internet connections, and the computing education knowledge and skills improved during the pandemic; however, more work is needed in each area. The types of devices matter. The age, portability, and means to charge a device impeded students' ability to connect with their teachers online. Donated devices are wonderful, but not all of them can be refurbished to the level that the students need. There are several organizations which are still dedicated to receiving donations and refurbishing them to provide families with devices. This ongoing process will continue to assist students, teachers, and families in the City.

Internet access, speed, and reliability are the keys to sustaining remote learning opportunities for students. Students lose interest and have a difficult time understanding directions particularly for synchronous learning sessions which are interrupted by bad connections. The policies to have broadband for all city residents will help alleviate these issues. While it will take time to completely implement this initiative, both the State and the City have allocated funds for broadband and built infrastructure to have personnel to oversee this effort.

The computing education knowledge and skills required to navigate the digital environment are not intuitive. The support provided by Code in the Schools and other organizations were invaluable to quickly answer questions on how to get online or troubleshoot a variety of issues for teachers and students. Community-based digital navigators are needed until all of our citizens improve their digital literacy, especially since technology integration during and after school has persisted in the city.

Even though digital equity has yet to be fully achieved in the City, the steps taken with these new policies are going in the right direction. The policies also had significant funding at each level which provided incentives to make changes. The pandemic also motivated collaboration within and between levels at a much more rapid pace

and provided the elevation of the parents' and teachers' insights to improve the computing education ecosystem.

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