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Teaching in the time of COVID-19: A biological systems theory approach

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In 2020, schools around the United States and globally closed to in-person instruction in response to the COVID-19 pandemic. This study, embedded in ongoing research supported by a United States Department of Education Jacob K. Javits Gifted and Talented Education Award, investigated changes in roles, relationships, and educational activities resulting from the pandemic as perceived by educators in one rural and low SES Appalachian primary school. Using Bronfenbrenner's (1977, 1979, 2001) Bioecological Theory of Human Development, this study examined instructional modifications (proximal processes) resulting from the pandemic (chronosystem) in the school and home (microsystem context) and the development of teachers, parents, and students (persons) in response to those changes. Survey data were collected pre- and post-pandemic onset. Results of this mixed-methods study indicated teachers perceived the pandemic as influencing what they taught, how they taught, and the roles of and relationships between teachers, parents, and students. Teachers adapted to the changing educational environment developing proficiency in online tools and skills to enhance communication. Parents assumed a more prominent role in their K-2 student's schooling to ensure students logged in and were active online, paid attention while in class, and completed their assignments at home. These remote learning environments, which naturally distanced teachers from their students, coupled with uncertain parental involvement, challenged teachers in their formative assessments of student knowledge. While some students thrived with increased support from attentive parents—many students, particularly those already at-risk or in homes where internet or parental support were lacking—were adversely affected, thus widening the achievement gap.

KEYWORDS

rural, Appalachia, vulnerable youth, COVID-19 pandemic, ecological systems theory, bioecological theory of human development, young children (K-grade 2)

Introduction

In spring 2020, schools around the United States and the world closed to in-person instruction in response to the Novel Coronavirus (COVID-19) pandemic. Six months later, as schools prepared to reopen, educators and policy makers continued to grapple with how best to educate students in this unprecedented environment. Educators were tasked with navigating a constantly shifting landscape to contain the spread of COVID-19 while at the same time ensuring that students received a quality education. Teachers were tasked with learning new skills and adopting new strategies to enhance student learning in a variety of new settings replacing the regular classroom, like "virtual," "hybrid," and "blended" classrooms, and to establish and maintain increased communication between school and home to support parents in their new role as educational partners. Recent research indicates that shifts in how educators provide instruction and support to their students and families resulting from the pandemic are paramount to student success (Hodgman et al., 2021). These shifts, however, are fraught with barriers that when left unaddressed adversely affect student learning, and teachers in high-poverty and rural areas are disproportionately affected (Caglayan et al., 2021; Hodgman et al., 2021; Vinson and Naftzger, 2021). With more than 56.3 million school-age children in the United States (National Center for Education Statistics [NCES], U.S. Department of Education, 2019) and 259 million worldwide (United Nations Educational, Scientific, and Cultural Organization [UNESCO], 2021) experiencing the pandemic, exploration of how classrooms are changing and how teachers, students, and parents are developing in response to this change is apropos. Because educational experiences for children in rural communities are qualitatively different from those of their urban and suburban peers, and with 12.5 million students or 25% of the total American student population attending rural schools (Aud et al., 2013), this study responds to calls for more research that informs educational processes specific to rural communities (e.g., Sherwood, 2000; Miller and Brigandi, 2020).

Using Bronfenbrenner's (1977, 1979, 2001) Bioecological Theory of Human Development as the theoretical framework, the purpose of this research was to identify changes in roles, relations, and activities resulting from the COVID-19 pandemic, and how developing persons within the educational system are experiencing this changing pattern of education through the lens of the classroom teacher. Development is measured by how well a person has adapted to the changing environment—learned what is possible to do in it, is motivated to engage in activities, and is able to transfer what they have learned to function more competently in the new context (e.g., Byrnes, 1996). Developing persons refers to the person on whose development we are focusing (Bronfenbrenner, 2001/2005), which in this study was the teacher, parent, and student. A subcomponent of a larger 5-year study funded by the United States Department of Education Jacob K. Javits Gifted and Talented Students Education Program Award to integrate computer coding into rural and low SES K-2 classrooms, research questions are as follows:

1. How confident were teachers in their ability to differentiate instruction prior to and during the COVID-19 pandemic?
2. In what ways has the ecosystem of schooling changed during the COVID-19 pandemic regarding setting, activities, and teacher, parent, and child roles within that setting?
3. How are teachers, parents, and children developing, or adapting and becoming competent in response to the changing ecosystem of school during the COVID-19 pandemic?

Background and theoretical frame

Bronfenbrenner's Ecological Systems Theory (e.g., Bronfenbrenner, 1977, 1979, 2001) provided a valuable lens for examining developmental changes in individuals, including teachers, parents, and students, in response to the ecological transition prompted by the COVID-19 pandemic. An ecological transition occurs "whenever a person's position in the ecological environment is altered as the result of a change in role, setting, or both" (Bronfenbrenner, 1979, p. 6). For illustration, how well does a person cope with entrance to elementary school or college? What happens when a person starts a new job, gets married, or retires? The onset of the COVID-19 pandemic qualifies as an ecological transition as it prompted change in the setting of school—from brick and mortar to remote learning in the home, or a combination of the two—and the roles of parents, teachers, and students within the newly changed school setting. Teachers were forced to rethink their pedagogical approach as in-person instructional techniques did not necessarily translate to online learning, redesign activities to engage students who were learning from home, and adjust their approach to time management in response to increased demands. Parents—often for the first time—gained an inside look into the previously veiled inner workings of the educational system. For parents of young school-aged children who could not work independently, the shift to remote learning in the home necessitated new levels of support and involvement. Students needed to adjust to new ways of learning, interacting with teachers and peers, and engaging with the curriculum.

We also looked at interrelations between individuals and their environment (Tudge et al., 1997; Bronfenbrenner and Morris, 1998; Rosa and Tudge, 2013)

and assessed those interactions within Bronfenbrenner's (2001) process–person–context–time (PPCT) model (Tudge et al., 2009; Rosa and Tudge, 2013). Processes that support human development, or *proximal processes*, are reciprocal interactions between evolving persons and their environment that are "progressively more complex. [and]. occur on a fairly regular basis over extended periods of time" (Bronfenbrenner and Morris, 1998, p. 996). Examples of proximal processes in previous research include maternal responsiveness (Drillien and Ellis, 1964), family warmth and hostility (Benson and Buehler, 2012), and joint attention and parent-child book reading (Farrant and Zubrick, 2011).

Person characteristics, such as the ways people behave, interact, and are perceived by others, also influence the trajectory of the developing person. A person's development may be affected by their age, gender, race, and ethnicity (e.g., demand characteristics), past experiences, skills, ability, intelligence, and social and material capital (e.g., resource characters), or temperament, motivation, and persistence (e.g., force characteristics). Child temperament, for example, mediates parenting practices that influence children's anxiety symptoms (Buss et al., 2021), which in turn affects academic performance in college (BlackDeer et al., 2021). Social capital predicts rural youth's educational aspirations regardless of SES, as does gender, with rural males having higher educational aspirations than their female counterparts (Byun et al., 2012).

Numbers, however, are not useful when considered outside of the events, ideas, or people that influenced them; they only make sense in some type of context. Research context involves identification of factors that guide interpretation of study findings, such as geographical location, culture, or historical period. Consider, for example, the importance of context when interpreting annual income, medical treatments, educational interventions, social policies, or the price of a hamburger. Bronfenbrenner (1979) envisioned context as a series of interrelated environmental systems—the microsystem, mesosystem, exosystem, and macrosystem—that influence individual development in significant ways. Microsystems are structures and processes in an immediate setting containing the developing person, such as the school, home, church, or neighborhood peer group (Bronfenbrenner, 1988).

Relationships between microsystems are mesosystems and comprise interactions such as those occurring between the school and home, or between the home and the neighborhood peer group. As examples of a mesosystem, parents can inform teachers about happenings in the home that might affect their child's learning in school, or they can participate in school events and activities. Teachers in turn can provide parents with learning resources and information that helps them to monitor their child's educational progress. School functions involving parents, like PTA memberships, parent-teacher conferences, and back-to-school nights (Xu et al., 2010; Muller, 2019), support the mesosystem. Research indicates that strong and supportive links between microsystems influence student development in positive ways. Children are more likely to be successful in school when their parents actively engage with teachers (Hornby, 2011; Muller, 2019) and when their peers participate in school activities (Finch et al., 2019) and value academic achievement (Wentzel, 2017).

The exosystem is like the mesosystem in that it includes linkages between two or more settings; however, unlike the mesosystem, the developing person is not an active participant in both settings (Bronfenbrenner, 1977). Consider the link between school administrative offices and either the classroom or the home. Decisions made at the district level may not directly involve teachers, parents, and students as active participants in the process, nonetheless, decisions made at the district level impact those individual's development in various ways. Access to high-quality and ongoing professional learning increases teachers' content knowledge, self-efficacy, and competence (Darling-Hammond et al., 2009; Croft, 2015; Akiba and Liang, 2016). Targeted spending on special education services and interventions contributes to students' academic achievement (Cruz et al., 2022). Academic schedules, curriculum, transportation, extra-curricular activities, and student support services are examples of school-level environmental elements decided in the exosystem.

The macrosystem is the culture, subculture, or social system in which the developing person resides, including "belief systems, resources, hazards, lifestyles, opportunity structures, life course options, and patterns of social interchange that are embedded in such overarching systems" (Bronfenbrenner, 2001/2005, p. 101). Our interest is in understanding the changing pattern of education because of the pandemic within the macrosystem of rurality (Green and Corbett, 2013; Azano et al., 2017; Rasheed, 2020). Shared cultural characteristics of rural communities include people's valuing of tradition, place, family, and religion (Richards and Stambaugh, 2015), and a close sense of community. Researchers examining the mesosystem of home and school in rural communities found tension resulting from competing values about the purpose of school between educators and parents and families (McHenry-Sorber, 2014). Rural community members often view school as standing in opposition to local life by teaching children that traditional rural lifestyles have nothing to offer (Corbett, 2007). Barriers to the educational success of children in rural communities include limited access to broadband and special services (Bright, 2020), teacher shortages owing to low pay and fewer opportunities for high-quality professional learning (Johnson and Reynolds, 2011; Holme et al., 2018), and smaller teaching staffs resulting in the

need for teachers and administrators to assume multiple roles and responsibilities (Preston et al., 2013). Life course options for children who want to stay in their rural communities are often hindered by economic decline and social and geographic isolation. Aspiring children are therefore conflicted on whether to lower their educational and career aspirations to stay in the community (Howley and Howley, 2006) or leave the community to seek better opportunities elsewhere (Corbett, 2007). Such decisions are especially conflicting for high-achieving and talented youth with strong family and community support.

The Chronosystem can refer to the impact of the passage of time on developing persons in two capacities—those internal to the developing person and those external to the developing person. These influential happenings can be normative age-based occurrences or non-normative historical events. Normative age-based occurrences are experiences common to all or many people, for example puberty, marriage, or retirement. Whereas non-normative experiences are associated with a specific historical time in which the normative events occur, like wars, natural disasters, social movements, and pandemics. Although people of the same age group may share similar experiences across time, for example, entering the workforce, the normative event of entering the workforce differed for people who sought employment during the industrial revolution and those who sought employment during the Great Depression. The normative event of coming of age, although experienced by all females, differed for females in the 20th century and those in the 19th century due to influences of the women's suffrage movement (Fawcett, 2017). In this study, we looked at the development of teachers, parents, and students in response to the non-normative event of the COVID-19 pandemic.

This study responds to calls by Tudge et al. (2016) for more research that describes, tests, and evaluates the four major concepts of Bronfenbrenner's theory—*proximal processes, person characteristics, context*, and *time*. We sought to identify changes in instruction (proximal processes) resulting from the pandemic (time) in the school and home (context), and the development of teachers, parents, and students (persons) in response to those changes as perceived by classroom teachers.

Materials and methods

Following the recommendations of Bronfenbrenner (2001/2005), we used a short-term longitudinal design in which data were obtained from the same group of subjects both before and after a particular life experience, in this case, the non-normative event of the COVID-19 pandemic. This research was emergent—it evolved from a larger in-progress study exploring how educators responded to professional learning in computer science and gifted education over time and the effects of teacher development on PK-2 students in a rural, low SES, and low education community. With the onset of the COVID-19 pandemic, we seized the opportunity to expand our study to learn about how the ecosystem of schooling was changing, how teachers were adapting to those changes, and how well teachers perceived parents and students as adapting to those changes.

Participants

Participants were 58 educators, comprising administrators (4%), teachers (86%), and teacher aides (10%). Participants were primarily female (96%); Most taught kindergarten (48%), followed by first (37%) and second grade (33%). The mean years of teaching experience were 11.64 years (SD = 10.47), with a minimum of 1 year of experience and a maximum of 40 years of experience. Many of the participants held a bachelor's (48%) or master's (43%) degree, one had a terminal degree (2%), and three (7%) held a professional endorsement.

Participants were purposefully sampled from one school serving approximately 800 PK-2 students in Appalachia. The school met the criteria for the Rural and Low-Income School Program (RLIS) as authorized under Title V, Part B of the ESEA, and for high-poverty as determined by section 1113(a)(5) of the ESEA. In fact, 90% of students were eligible for Free and Reduced Price Meals (FARM) and 27% lived below the poverty line, exceeding the ESEA requirements of 50% and 20%, respectively.

Procedure

This study utilizes a mixed methods design. Teachers completed two online questionnaires including open- and closed-ended questions spanning 9-months—3 months prior to the onset of the pandemic and 6 months into the pandemic—to measure respondent behavior, preferences, and attitudes over time—and to analyze reasons for changes in behaviors or preferences.

Data sources

To address the first research question (i.e., *How confident were teachers in their ability to differentiate instruction prior to and during the COVID-19 pandemic*?), teachers were asked to answer three items selected from the Teacher Self-Efficacy Scale-Instructional Subscale (Tschannen-Moran and Woolfolk, 2001): I am confident in my ability to (a) adjust my lessons to the proper level for individual

students, (b) Gauge student comprehension of what I've taught, and (c) meet a wide range of student ability by differentiating my lessons. Teachers responded to these prompts by selecting from 1 (strongly disagree) to 7 (strongly agree).

This three-item survey was administered twice: in January 2020 and in September 2020. In January 2020—pre-COVID-19—teachers responded to the above prompts regarding their current instruction in the classroom. In September 2020, teachers were asked to respond to these same items twice: first in reference to their instruction prior to the instructional changes due to COVID-19 and a second time in reference to their current instruction. The reliability of the items at each time point was high (January 2020: $\alpha = 0.92$, September 2020 referencing pre-COVID confidence: $\alpha = 0.98$, and September 2020 referencing current confidence: $\alpha = 0.92$).

In September 2020, six open ended questions were added to the survey to provide more detailed information on how teachers perceived education as working during the COVID-19 pandemic. Open ended questions were designed to elicit responses that aligned with categories of the PPCT while still allowing flexibility for responses to fall into multiple categories. For example, the question "Describe COVID-19 related barriers that hinder your ability to differentiate instruction for all of your students" yielded responses coded as *Person* (e.g., children sleeping during virtual lesson, parents not communicating with teachers), *Proximal Processes* (e.g., not being able to hold regular small groups, creating packets of work), and *Context* (e.g., not having students in-person). Other questions included: (a) List groups of students for whom meeting academic needs is more challenging this school year and explain why, (b) How have changes in instructional delivery modes affected your confidence in your ability to differentiate instruction, (c) Describe COVID-19 related changes that make it easier for you to differentiate instruction for all your students, (d) Describe COVID-19 related changes that make it easier for you to differentiate instruction for your students with high academic ability, (e) Describe COVID-19 related barriers that hinder your ability to differentiate instruction for your students with high academic ability, and (f) Is there anything else you'd like us to know about how you are delivering instruction this school year?

Positionality

The qualitative coding team comprised three members: the first author and principal investigator, the third author and co-investigator, and the fourth author and graduate research assistant. The first coder is an Associate Professor at a Research 1 University and holds a Ph.D. in Educational Psychology. The second coder is a Professor and Master Teacher in STEM education with an Ed.D. in Curriculum and Instruction. The third coder is a third-year graduate assistant pursuing a Ph.D. in Learning Sciences and Human Development with completed coursework in learning theory and advanced qualitative methods. Together, the coding team members have extensive research experience including funded grants and publications in peer-reviewed journals. All three coders were previously classroom teachers in elementary, or secondary school. The rooting of the data analysts in different disciplines within education–gifted, science, and learning sciences–in conjunction with differing levels of professional experience, brought diversity of perspective to the analytical process that encouraged robust discussion, while at the same time, the different levels of professional experience supported both theoretical and applied directions.

Analysis

Quantitative data were analyzed using paired sample and independent sample *t*-tests. Qualitative data were analyzed thematically using inductive and deductive coding (Boyatzis, 1998). Deductive codes were derived from Bronfenbrenner's (2001) Bioecological Theory involving synergistic connections among proximal processes, person characteristics, context, and historical time (PPCT; Tudge et al., 2016). The research team also considered Bronfenbrenner's (1979, 1989) earlier work on contexts for human development including environmental systems (i.e., the microsystem, mesosystem, exosystem, macrosystem, and chronosystem), and coding schema used by other researchers to develop theory-driven codes (Boyatzis, 1998). The processes of inductive and deductive coding were simultaneous and iterative as the researchers wanted to provide theoretical context while at the same time staying close to the data (Wolcott, 1994).

Inductive codes emerged from the data using the six-phase process outlined by Braun and Clarke (2006), including (a) becoming familiar with the data, (b) generating initial codes, (c) searching for themes, (d) reviewing themes, (e) defining and naming themes, and (f) producing a report. First, data were downloaded to an excel template and the three coding team members independently read, took notes, and marked ideas to gather initial insights. Next, team members discussed issues of potential interest and emerging patterns across questions and respondents, and manually coded short segments of data with general topic codes (Merriam, 2009). Examples of initial topic codes included "*the teacher is stressed*," "*classes meet less often*," and "*changes in teaching modality*." Team members collaboratively created a thematic map of independently created codes to make the data visible and to encourage discussion of

emerging themes (Saldaña, 2015; see **Supplementary Appendix A**). For example, the coding team members independently coded participant references to technologies as "*lack of computers*," "*lack of tech savviness*," and "*lack of reliable internet access*," with the ensuing discussion centered on the potentially emerging theme of COVID-related barriers to instruction. In phase 4, team members applied their knowledge of Bronfenbrenner's (1979) Ecology for Human Development Theory to guide identification of meaningful themes (Boyatzis, 1998). Some initial codes and inductively derived themes naturally fit with the deductive theory-driven codes. For example, team members unanimously agreed that participant references to changes in curriculum and instruction, class meeting times, and school meeting formats inductively classified as "imposed structures" naturally aligned with Bronfenbrenner's description of the exosystem and the theory-driven code "context." Other attempts at alignment prompted discussion, re-immersion into Bronfenbrenner, Bronfenbrenner's (2001, 1979) theories, and solicitation of input from two educational and developmental psychologists schooled in Bronfenbrenner's work (i.e., audit process; Lincoln and Guba, 1985). Interrater Reliability (IRR) for the 5th round of segmented coding, which was calculated by dividing the number of agreements by the number of agreements plus the number of disagreements (Miles and Huberman, 1994), was 90% after negotiated discussion.

Results

Research question 1: How confident were teachers in their ability to differentiate instruction prior to and during the COVID-19 pandemic?

We examined whether teachers self-reported similar confidence in their ability to differentiate before the instructional changes due to COVID-19. Because of teacher turnover, the two samples were different enough that we elected to use the more conservative independent sample *t*-test with unequal variances assumed. The January 2020 teacher self-reported differentiation confidence (M = 6.10, SD = 0.76, n = 45) and the September 2020 teacher self-reported differentiation confidence prior to the onset of COVID-19 (M = 5.98, SD = 1.31, n = 34) were not statistically significantly different from each other [$t(59)$ = 0.46, p = 0.65]. These results indicated teacher self-reported differentiation before the onset of COVID-19 in January 2020 and teacher self-reported differentiation in September 2020 referencing pre-COVID-19 were similar—in other words, teachers' confidence before COVID-19 and their recollections of their confidence prior to COVID-19 aligned—teachers did not appear to have rose-colored glasses of pre-COVID conditions.

Next, we compared the teachers self-reported confidence in their differentiation in September 2020 in both pre-COVID (M = 5.98, SD = 1.31, n = 34) and the mid-COVID conditions (M = 4.59, SD = 1.58, n = 34) using a paired samples *t*-test. Results indicated teachers reported statistically significantly lower confidence in their ability to differentiate during COVID-19 as compared to before COVID-19 [$t(33) = -4.30$, $p < 0.001$] (see **Figure 1**).

Research question 2: In what ways has the ecosystem of schooling changed during the COVID-19 pandemic regarding setting, activities, and teacher, parent, and child roles within that setting?

Teachers described changes to the ecosystem of school during the COVID-19 pandemic that involved new ways of teaching and learning, and new ways of dividing responsibilities for student learning between the school and home. Teachers further described changes in the context of school, processes within that context, and in the roles of parents, teachers, and students. These changes in turn required teachers, parents, and students to learn new skills to adapt and successfully navigate the changing educational environment.

Macrosystem

Common to students in rural and high-poverty communities, teachers perceived children in this Appalachian community as particularly vulnerable to instructional changes during the pandemic due to limited access to a stable Internet connection leading to disrupted virtual learning and communications. Teachers noted the need for both "more access to the Internet" and "better Internet" to adequately meet the needs of their students. Uncommon to rural and high poverty schools, however, teachers noted having access to a wide array of costly resources, like computer hardware and software. "We just recently supplied students with technology (ipads) so that should help with remote instruction" and we are communicating through "Dojo," "Teams and Schoology." Decisions regarding these resources, as well as creative solutions to Covid-related instructional issues like establishment of mobile hot spots affording parents and students free Wi-Fi access, were made in the exosystem by governing boards charged with oversight of educational

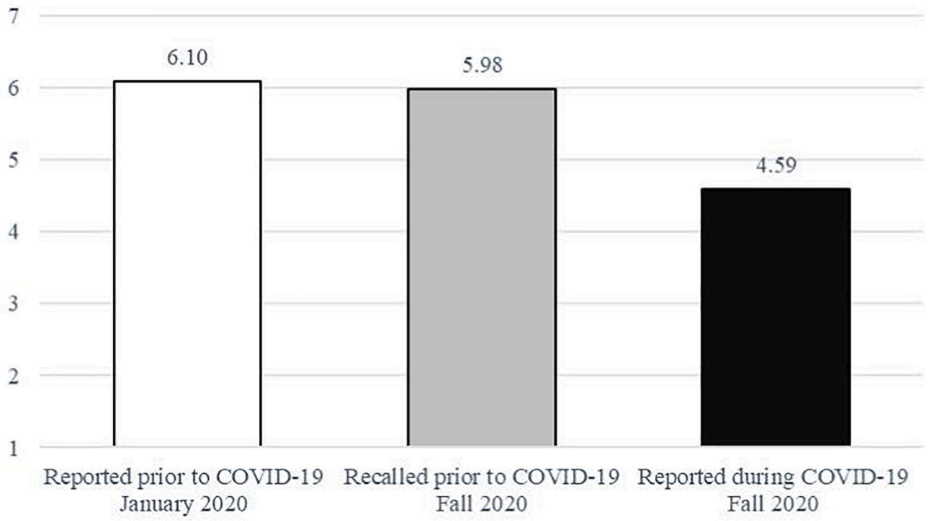

FIGURE 1
The average teacher self-reported confidence in their ability to differentiate reported January 2020 prior to the onset of COVID-19 (white), fall 2020 recalled confidence for pre-COVID-19 onset (gray), and fall 2020 reported confidence after COVID-19 onset (black).

quality before pandemic onset, and building a district plan post-pandemic onset.

Exosystem

Teachers noted that policy makers were required to quickly make consequential decisions on how best to facilitate learning in the absence of a physical place—to decide what children should learn, how adults could support that learning, and later, with the pandemic still raging, how to keep individuals safe when returning to a *"brick-and-mortar"* classroom. These district-level decisions encompassed school setting, curricula, technologies, schedules, and safety protocols—put another way—how students accessed school, what they learned in school, and when, where, how often, and how long students attended school. Although teachers noted district-provided supports as being quickly implemented, they also noted inherent barriers to instruction and learning in these newly adapted systems and reported increased levels of anxiety resulting from lack of inclusion in decision-making processes.

School setting

Teachers used terminology such as "*online,*" "*virtual,*" "*blended,*" "*face-to-face,*" and "*brick and mortar*" to describe school modality, or how students accessed school. This terminology reflected not only a change in school setting, but the rethinking of school as an experience, action, or condition, as opposed to a place—in other words, as a verb instead of a noun. Rather than referring to the institution where instruction was given, during the COVID-19 pandemic, the term *school* referred to the act of providing instruction irrespective of place. Freed the physical features of the school setting that previously defined activities that could take place, the move from the classroom to the virtual realm changed not only where learning happened, but how learning happened.

Technologies

Teachers noted using numerous distract-adapted technologies to facilitate a new conception of school unbounded by a physical space. Students were issued iPads so that they could access school virtually from home. Synchronous and asynchronous online conferencing systems like "*Schoology*" and "*Microsoft Teams*" supported new ways of facilitating learning in a digital setting, as did interactive online curricula like "*Imagine Math*" and communications platforms like "*ClassDojo*." Already in use testing programs like the *"Phonological Awareness Literacy Screening* (PALS)" provided archival data on individual student benchmarks that guided teachers' online instructional practices.

Schedules

Teachers noted decreased duration and disjointed frequency of school instructional time as a barrier to student learning post-COVID onset with statements like "The teachers have very limited time with the students," "I only see my students once every 2 weeks, so if they miss my class it's a month before I see them again," "we do not have a consistent amount of time to work with students on a regular basis," and more simply, "Not enough class time." When virtual, screen time limits for young

children reduced the amount of direct teacher interaction with students, as did a delayed start to the school year. As one teacher summarized,

I signed up to do my grade level virtually. Because it is 2nd grade, we are not allowed to be on the computer too long with the students. I meet two times in the morning for about an hour and 15–30 min, then I have a few intervention group meetings. We did not start the intervention until November, so I just feel like I am not really working with my students.

When face-to-face, teachers similarly noted fewer days in the classroom with statements like "I only see them 2 days," and "We have used the blended model and at times have been full remote missing full weeks of school at a time." In short, teachers perceived lack of direct instructional time with students as a problem in all learning formats during the COVID-19 pandemic, including face-to-face, blended, and virtual.

Rapidly changing settings and schedules, in combination with lack of control over decisions and consequences, were noted by teachers as contributing to their already high levels of anxiety about educating students during the pandemic. "It is about to change," stated one teacher referring to school setting, "I'm not sure how I will be teaching in a few weeks." "Due to circumstances yet to be determined," stated another, "I may be switching to fully face-to-face in a couple of weeks," and "I'm about to go back to face to face. I think." "[We need] consistency with decisions made by the board. The students and teachers keep getting pulled every which way. We are only a part of a plan." "It is extremely stressful. We need support from the Board Members and 'people in charge' more than ever." "This is a very trying educational year."

Curriculum

Decreased instructional time resulted in a district-level decision to narrow the range of school curricular offerings, revealing assumptions and beliefs about what children should learn and exacerbating existing trends prioritizing specific academic intelligences over other intelligences needed by children to become successful adults, for example, creative intelligences. "We have been told to cut everything but core math and reading," stated one teacher. Music, art, and physical education are disregarded.

Safety protocols

District-level safety protocols noted by teachers when returning to the brick-and-mortar classroom included "mask-wearing," "assigned seating," and "social distancing." These protocols, while designed to keep students safe, were noted by teachers as a COVID-related barrier to effective instruction. "Students cannot be grouped properly because of social distancing," stated one teacher. "Limited face to face and social distancing hinders all areas," stated another. As a result, "The group community usually built has barely surfaced. All students suffer in one or more ways—academically and emotionally."

High levels of teacher anxiety over safety concerns added complexity to an already daunting task—providing effective instruction in a modified environment. "I worry for the safety of the children, their families, and us here at school. This is just scary!"

Every-day there is a stale fear of who you come into contact with. It hinders the ability of a teacher to dive into the resource of their own creative mind as they find more creative ways to keep safe during the pandemic. Or our mind is simply too busy trying to survive while juggling delivering the best instruction to our students.

As one teacher summarized when describing her experience of teaching during the COVID-19 pandemic, "Teaching is no longer #1 but rather insuring safety for all. I think we made real strides in dealing with pandemic when it comes to safety but were overwhelmed by the educational challenges."

Microsystems

The microsystems of school and home, including patterns of activities, roles, and interpersonal relationships of people within those systems, evolved in response to the needs of students and changing organizational structures during the ecological transition of the COVID-19 pandemic.

School. Teachers noted changes to classroom activities—instructional practices, assessment, and behavior management—that were responsive to school modality and safety protocols. These changes in turn affected the role of the classroom teacher, and their relationships with their students. For example, prior to COVID-19 onset while in the brick-and-mortar classroom, teachers recalled activities as including in-class assignments that they formatively assessed in real time, grouping students in response to shared interests and abilities, monitoring behaviors and work habits, providing verbal feedback, observing social interactions, and formatively assessing academic and social development daily. Post COVID-19 onset while virtual schooling, teachers described creating packets of work for students to complete at home in lieu of in-class assignments, using technologies that provided instruction and practice opportunities that adjusted to the level and pace of each individual child without teacher input, and sporadically meeting with students *via* remote learning platforms. "Our county is using the Imagine Math program, which allows students to move ahead or slowdown in the math curriculum at their own pace" stated one teacher. "With reading I have PALs, which I can trust to be their real level," stated another.

These changes to proximal processes had the unintended consequence of hindering teachers' ability to formatively assess students' abilities and content mastery. This in turn diminished

the quality of the teacher and student relationship. "In a 'regular' classroom setting," stated one teacher, "I would walk around and see if they [students] needed help or if they were able to do it [classwork] alone." In the virtual classroom,

Getting to know the students and their true abilities has been challenging. They are shy to participate in whole group online meetings, it's hard to develop a sense of community in the [virtual] classroom, and when parents help them complete most of their work [at home], everyone looks like they are on level and capable of the work.

Even after returning to the regular classroom, safety protocols—like social distancing, assigned seating, and mask wearing—required modifications that continued to hinder formative assessment and negatively affect teacher and student relationships. "Students cannot be grouped properly because of social distancing" stated one teacher. "Small groups are harder," stated another,

explicit phonics instruction is harder because they [students] need to see and hear up close the sounds and the way you form your mouth. Mask and shields get in the way of that, and in the way of you seeing if they are forming their mouth properly.

Home

Change in any microsystem requires adaptation and potentially evolution of a new pattern. The change in school setting from brick and mortar to virtual necessitated parental support in the home in new ways. Parents needed to learn new skills—to use new technologies to facilitate their child's learning at home and to communicate with classroom teachers in the absence of a face-to-face option. Parents needed to provide an environment conducive to student learning within the home, and because of the young age of children in this study, to assist their children in navigating online platforms, ensure they logged into virtual classes on time, completed their schoolwork at home, and then return that completed work to the school for assessment. This new way of schooling confounded the microsystems of school and home in new and complex ways, and teachers perceived parental engagement as a requirement for student success, with students whose parents were more adept as more likely to succeed.

Research question 3: How are teachers, parents, and children developing, or adapting and becoming competent in response to the changing ecosystem of school during the COVID-19 pandemic?

Teachers

Teachers perceived themselves as progressively adapting in response to the changing school environment, although not without struggle. They reported engaging in activities to learn new skills, being motivated to engage in those activities, and becoming more competent in transferring those new skills in multiple modalities to support student development. The primary area of development noted by teachers was in using new technologies. Teachers reported using new technologies to interact with students with statements like "I am doing Teams meetings with my students" and "I'm making pre-recorded videos to help with social distancing." Teachers also reported using technologies to differentiate instruction in response to student ability and readiness. "Now that we recently have sent home iPads," stated one teacher, "we can specifically have students work on a specific skill using their iPads." "With Schoology," stated another, "I can assign higher levels of readings, sight words, and spelling."

Overall, teachers expressed feeling confident in their ability to use newly acquired skills to improve their current and future instruction irrespective of school modality.

The skills I have gained working online will enhance my instruction in the classroom. The struggles I have faced to increase student engagement online have taught me some valuable lessons on how to keep students engaged. Hopefully, those skills can be transferred to face-to-face instruction.

Struggles noted by teachers included challenges in mastering digital tools to teach virtually and "glitches" or breaks in network function or continuity. The most common area of struggle noted by teachers post-COVID-19 onset, however, was establishing individual relationships with students. Teachers perceived their connectedness to their students as mediated by reduced instructional time, little face-to-face interaction, and somewhat ironically, the same technologies purported as supporting differentiated instruction. The result was that teachers indicated not "knowing" their students, and therefore, as unable to gauge students' areas of mastery or struggle. "Because I am not in the classroom as much, I cannot keep up with what the students are learning and retaining," stated one teacher. "I do find it hard to differentiate through Microsoft Teams" stated another, "I find it really difficult to have individual work time so that I can see what they [students] are struggling with on their own." "I haven't been able to get to know my kindergarten students, so it is hard for me to remember which ones need extra attention."

Parents

Teachers described variation in parent competency to support their children's learning in the changing ecosystem of school during the COVID-19 pandemic that potentially widened the existing gap in achievement between students with involved parents and those without involved parents. As parents of young children, parents needed to assume increased responsibility for student learning from the home, including

helping students to login to class at set times, access online assignments and resources, and stay engaged during virtual class sessions. Parents themselves needed to learn to use technologies to meet virtually with teachers. Teachers described parent development as either categorically generative or disruptive.

Developmentally generative parents were described by teachers as curious, responsive, and actively engaged in activities with their children—they communicated with teachers about happenings in the home and advantageously adapted to the changing educational environment. "I am getting a lot of feedback from parents that they have a hard time keeping their child-focused [during virtual learning]. I mean they [students] are home so of course they want to play and be a kid," stated one teacher indicating parental engagement and communications. Teachers in turn credited developmentally generative parents as positively contributing to the educational process with statements like, "For some of the children, having one-on-one time with their parent to help them has been a blessing. Some of these children are getting a lot of school support at home" and "I have been able to differentiate lessons in ways that I was unable to do so before [the pandemic] due to parent involvement in teaching."

Developmentally disruptive parents, in contrast, were described by teachers as comprising two extremes: apathetic, inattentive, and unresponsive, or overly helpful, impulsive, and seeking self-gratification. Apathetic, inattentive, and unresponsive parents did not take advantage of educational interventions or engage in educational activities with their children at home. "Students are not getting enough instruction because no one is working with them at home and families are not reaching out or accepting help when offered" stated one teacher. "Barriers that hinder my ability to differentiate instruction have been parents do not log back on for their child's independent or small group time, attendance, turning work in, children sleeping during virtual lessons, etc.," stated another. Unresponsive parents did not communicate with the classroom teacher, even when provided with resources to easily support that communication. "Most families have not taken advantage of TEAMS meetings or pre-loaded lessons on ClassDoJo." To better meet the needs of my students, I would like "parents to communicate with me better and more. Or even just answer me on Dojo messages."

Behaviors attributed by teachers to overly helpful, impulsive, and attention-seeking parents included responding to in-class questions directed at students during virtual learning sessions and completing their children's homework.

During the blended model, our students complete packets of work when they are not in the brick and mortar school. Completing the work from home has made it difficult for me to gauge if the student is actually doing the work or if parents are doing the work. When they [students] are here [brick and mortar], the gaps continue to grow.

Students

Teachers noted Person characteristics of students' age, ability level, special learning needs, and socioeconomic level as moderating learning during COVID-19, with students in need of special services suffering disproportionately. Specific terminology included used by teachers when describing at risk students included "SAT, IEP, Gifted," "Title 1 groups," "severe," and "those below grade level." SAT refers to students with Special Assistance Teams (SATs) an IEP refers to an Individualized Education Program—both are special education interventions to support the progress of students who struggle with a general education, or in the case gifted, require advanced educational options. Resource characteristics included "Students who do not have access to internet [and] students whose parents work through the day."

Exacerbating factors for these subgroups of students included reduced and inconsistent instructional time, elimination of supplementary educational and support activities in and outside of normal school hours, and increased reliance on parents to provide supports at home. Regarding ability, teachers stated, "Students who are below grade level are really struggling. They need consistent, in-person, one-on-one instruction." "For severe kids, online is not really working for them. They do well with remote packets only if the parent is willing to engage." Teacher statements pertaining to the development of young children included, "While online I cannot tell if students are learning all they are supposed to learn in kindergarten like I could face-to-face as kindergarten is a very social grade." "I have a limited amount of time I get to spend with my virtual class due to their attention span and screen time limit."

Discussion and implications

This research is timely and provides insight into the newly explored phenomenon of factors affecting the development of young children, their teachers, and their parents during a historical time—the COVID-19 pandemic—in alignment with Biological Systems Theory (Bronfenbrenner, 1977, 1979, 2001). Findings are discussed categorically below as follows: (a) Proximal processes, (b) Context, and (c) Persons.

Proximal processes

Changes in proximal processes to support education during the COVID-19 pandemic included increased use of technologies, like Learning Management Systems (LMS) and instructional and assessment technologies, and packets of work completed by students at home. Findings revealed changes in proximal processes affected formative assessment, teacher confidence, teacher and student relationships, and

differentiated instruction, all factors that support student achievement (e.g., Black and Wiliam, 1998; Hattie, 2008; McCormick and O'Connor, 2015; Grosas et al., 2016; Andersson and Palm, 2017; Engels et al., 2021), and potentially reduce gaps between high achieving and low achieving students (Salar and Turgut, 2021). Formative assessment refers to a wide variety of methods that teachers use to conduct in-process evaluations of student comprehension, learning needs, and academic progress during a lesson, unit, or course (Glossary of Education Reform, 2014). Examples of formative assessment include in-class discussions, casual chats, informal observations, and student completed work. Without these informal ways to check student understanding, teachers struggled to discover which students learned new ideas, concepts, and processes, and when, where, and how certain information needed to be re-taught or reviewed (Alber, 2011).

In theory, changes to proximal processes during the pandemic should have supported differentiated instruction. For example, adapted technologies provided teachers with individual assessment data and allowed students to work at their own pace. Online platforms had grouping features supportive of student collaborations, and packets of work permitted individualization in response to student readiness, interest, and learning profile. Quantitative findings, however, indicated teachers experienced a decline in their confidence to meet the individual learning needs of their students during the COVID-19 pandemic. Qualitative analysis allowed us to explore nuances in this discrepancy more carefully.

Traditionally, differentiated instruction requires active teacher engagement in the process of connecting content, process, and product to students' readiness, interests, and learning profile (Maker, 1982; Tomlinson, 2017). Previous research found lack of teacher training and resources, poor student attendance and attitudes, and environmental strains as adversely affecting differentiated instruction during the pandemic (Idrus et al., 2021). Vagos and Carvalhais (2022) concluded that online learning was an impersonal alternative for students lacking social stimuli in comparison to face-to-face learning. This research found that changes to proximal processes disconnected teachers from formative assessment activities and information necessary for the development of beneficial teacher and student relationships. For example, online learning restricted interaction opportunities and provided students with access to technologies that personalized instruction and provided feedback without teacher input. Concerns over the extent to which students autonomously completed homework also disrupted teachers' ability to assess content mastery. Much research supports the role of positive relationships in school settings, either in person (McCormick and O'Connor, 2015; Engels et al., 2021) or online (Lai and Xue, 2012; Hebebci et al., 2020). By revealing formative assessment as a relationship-building tool, this research contributes to those findings.

Context

The context of this study was one rural and low SES primary school in Appalachia serving students in grades K-2. Findings indicated teacher perceptions of an existing educational power structure that allowed the local school board of education to make consequential decisions with little input from the people affected by those decisions, including teachers and parents. Although teachers reported increased anxiety resulting from decision-making uncertainty, they also credited the school board of education with quickly providing costly resources to mitigate pandemic effects on student learning. This account differs from descriptions of rural communities commonly depicted in media and research as not valuing education, and as suffering disproportionately during the pandemic due to lack of resources (Caglayan et al., 2021; Hodgman et al., 2021; Vinson and Naftzger, 2021). Like depictions of rural communities, teachers noted issues with access to broadband (Bright, 2020) and potential competing values and interests pertaining to school (McHenry-Sorber, 2014).

This research revealed a shifting of the power relationship in the mesosystem of school and home, particularly regarding reciprocity. Reciprocity refers to the balance of giving and receiving in a relationship with the goal of creating a healthy and mutually beneficial partnership (Applebury, n.d.). In relationships that are strong and healthy, power is generally equal or close to equal with both parties having similar abilities to exert influence (Nguyen, 2022). The move of instruction and learning from the brick-and-mortar school into the home necessitated a rebalancing of the pre-COVID power structure, with parents assuming more responsibility for their children's education in the home (Shao et al., 2022). Given the importance of parent involvement in the academic success of their children (Lambert et al., 2022), this begs the question—should school ever have been a microsystem separate from the home or should school always have been a mesosystem comprising both school and home? Given the requirement for active engagement to generate learning mastery (Hattie, 2008), should school ever have been a noun as opposed to a verb?

Tudge et al. (2016) stated that not only should theory inform research, but that research should also inform theory. By suggesting school as a mesosystem comprising school and home as opposed to a microsystem, this research responds to that call. Bronfenbrenner (2001/2005) envisioned proximal processes as occurring only in microsystems to support the development of the Persons within those microsystems. Interpersonal interactions were likewise considered part of the microsystem. In contrast, this research suggests that proximal processes pertaining to the education of young children in the time of the COVID-19 pandemic occurred in the school-home mesosystem encompassing the development of parents and teachers, who synergistically interacted with the developing child (Xia et al., 2020).

Persons

Characteristics of the person influence their development and help determine their participation in the ecosystem (Shelton, 2019). Person characteristics like ability, disability, skill development, temperament, responsiveness, experience, impulsiveness, and illness affect the Person's capacity to engage in proximal processes that require progressively more complex interactions over extended periods (Bronfenbrenner and Morris, 2006). Most teachers perceived themselves as developing—they portrayed themselves as motivated and responsive, and as becoming progressively more adept at mastering the skills needed to successfully navigate the new school environment.

Teachers perceived parents as developing both generatively and disruptively (Bronfenbrenner and Morris, 2006). Generatively developing parents embraced opportunities to engage in their child's education in constructive ways that were advantageous to their child. Disruptively developing parents did not embrace opportunities to engage in their child's education, or they engaged in those opportunities in unconstructive ways that were disadvantageous to their child. Again, because development varies substantially as a function of the characteristics of the developing Person (Bronfenbrenner and Morris, 2006), parent characteristics affecting development were likely *revealed* during the pandemic and not *caused* by the pandemic. As an illustration, parents perceived by teachers as unresponsive may have been working multiple jobs, struggling with mental health issues, caring for multiple children, or lacking skill development to help with homework (Shao et al., 2022). Parents viewed as overly helpful may have themselves grown up in a tense and controlling home environment resulting in other-oriented perfectionism or narcissism, and therefore highly susceptible to life's setbacks (Flett et al., 2014). Nevertheless, the literature is clear that students with adaptive parents are more likely to succeed academically than their peers with maladaptive parents (Hill and Tyson, 2009; Cyr et al., 2022), suggesting the move to remote learning during the pandemic exacerbated existing inequities.

Children perceived by teachers as most at risk during the COVID-19 pandemic included the very young, those requiring special education services or performing below grade level, those with high academic ability or performing above grade level, and students from low-income families eligible for Title 1 services. By socializing with their peer group, young children learn to foster empathy, acquire language skills, discover the concepts of sharing and teamwork, gain confidence, become more prepared for school, create friendships, and understand how identities are negotiated in increasingly multicultural societies (de León, 2007; Goodwin and Kyratzis, 2007; Pepler and Bierman, 2018). Title 1 services that provide early interventions for young children and their low-income families reduce future grade retention and placement in special education services (Barnett and Hustedt, 2005). Early special education interventions can improve children's cognitive and social outcomes in inclusive school settings (Guralnick, 2017), and gifted education interventions help children with high academic ability to actualize their potential (Casa et al., 2017), and increase psychosocial outcomes, like self-efficacy, motivation, goal valuation, and environmental perceptions (Steenbergen-Hu et al., 2020). Support services during and after school hours for special groups of students are important in all contexts, but particularly so in rural and impoverished communities that are geographically and culturally isolated (Kettler et al., 2015; Stambaugh and Woods, 2015).

Limitations

This study examined teacher perceptions of the changing educational conditions pre and post onset of the COVID-19 pandemic in one primary school in a low-income and low-education rural Appalachia community. It is expected that this study provides insight into the teaching environment and teachers' experiences in navigating a cataclysmic event affecting all aspects of teaching and learning, yet it is not expected that this one school is representative of all teachers, all students, and all schools during this time. Although this study was contextualized in a rural, low SES, and low education community, study participants were not individually differentiated by social address labels, like income level or level of education. We instead looked holistically at development resulting from active participation in proximal processes regardless of individual social characteristics within the rural community. Additionally, only teachers' perceptions were gathered throughout this study—no students or parents were surveyed—thus all parent and student development is from the point of view of the participating teachers, which may provide an incomplete story.

Future research

To minimize the limitations of this study, future studies should explore the effects of the pandemic on subgroups of students within and across contexts, including rural, urban, and suburban. Future research should also consider the perspective of parents, students, administrators, and policy makers to gain a more encompassing perspective of the COVID-19 phenomenon, including changes to proximal processes and the effects of those changes on developing students. Questions raised include: How can we use lessons learned during this educational shift to improve our subsequent practice? Will teachers' confidence in their ability to differentiate return to pre-pandemic levels, or will it be altered in a more substantial way? Are there ways to better support parents in creating positive learning environments for their children at

home? More methodologically rigorous research may provide a stronger evidence base for the use of proximal processes, roles, and relationships as efficacious interventions for children's academic success.

Conclusion

This study examined how teachers perceived themselves, their students, and their students' parents as developing in response to a global pandemic that affected what, where, and how education happened. In doing so, this research exposed existing power structures in education, revealed what society prioritizes in difficult situations, explored shifting dynamics and expectations in the mesosystem of school and home, and identified inequities in student learning that were exacerbated by the challenges of the pandemic classroom.

Despite increased technological advantages leveraged to support virtual learning during the pandemic, teachers experienced reduced confidence in providing differentiated learning for their diverse students. The required use of technology, combined with learning structures imposed as school safety precautions, reduced teacher-student interactions, and decreased teachers' capacity to engage in successful formative assessment to properly moderate student learning experiences to best meet their needs.

Previous studies have provided evidence that the global COVID-19 crisis is exacerbating existing inequalities and marginalization between vulnerable and non-vulnerable groups (Hamilton et al., 2020; Stelitano et al., 2020; Hodgman et al., 2021; Vinson and Naftzger, 2021). Students in rural Appalachian were at a greater risk of being excluded from gaining access to equitable education prior to the onset of the COVID-19 pandemic due to socioeconomic, geographic, and cultural disadvantages inherent to rural communities (Hammer et al., 2005; Howley et al., 2009; Azano et al., 2014; Croft, 2015; Kettler et al., 2015; Stambaugh and Woods, 2015). This research exposed Person characteristics, like student exceptionality and parent responsiveness, as exacerbating disparities in this already vulnerable population and posing additional educational challenges for teachers and local policy makers. Habitats never demise for only one reason. Interventions to create environments that shape human development must consider the interplay of biological, social, economic, and ideological forces that shapes them, both as individuals and as groups (Bronfenbrenner, 2001/2005).

Data availability statement

The datasets presented in this article are not readily available because the IRB determined that information collected for this study will not be used or shared, even if identifiable information is removed.

Ethics statement

The studies involving human participants were reviewed and approved by West Virginia University Institutional Review Board. Written consent was waived as data collection was anonymous and presented no more than minimal risk.

Author contributions

CB, NS, and JS contributed to conception and design of the study, contributed to qualitative analysis, and analyzed and coded qualitative data. NS and JS organized the data base. KR-H analyzed quantitative data. CB, NS, and KR-H wrote sections of the manuscript. All authors contributed to manuscript revision, read, and approved the submitted version.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Publisher's note

Supplementary material

The Supplementary Material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/feduc.2022.964492/full#supplementary-material

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