

Technology integration for young children during COVID-19: Towards future online teaching

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Abstract

To support young children's learning during the coronavirus 2019 (COVID-19) pandemic, preschool educators in Hong Kong were required to teach with digital technologies. In this study, 1035 educators from 169 preschools reported their views and practices in an online survey, which we examined via *multilevel mixed-response analysis* and *thematic analysis*. More than half of the respondents (53%) expected future online teaching to continue, and only 11% of educators believed that parents would reject this form of delivery. Administrators and teaching assistants were more likely than teachers to expect online preschool teaching to continue in the future. In addition, respondents with existing online platform experience, who taught the upper levels of preschool, or incorporated specific teaching practices (eg, after the online lesson, they assessed children and assigned homework tasks), were more likely than others to expect online teaching in the future. Many of these respondents also reported (a) difficulty with engaging their children when online and (b) inadequate support from parents for learning activities, which reduced the respondents' perceived likelihood of future online teaching. Administrators and teaching assistants were more likely than teachers to believe

that parents would accept online teaching in the future. Respondents who felt they had inadequate training to teach online, children in families with inadequate technical skills and parents who believed that online lessons harmed children's well-being, were less likely than others to believe that parents would accept online teaching in the future. These educators believed that online learning communities could connect parents and schools and foster interaction that could help align with educator's support for children's learning needs.

KEYWORDS

COVID-19, digital technology, early childhood education, online teaching

Practitioner notes

What is already known about technology integration for young children during COVID-19

- COVID-19 led to the closure of many schools, requiring teachers to teach online.
- Barriers to integrating technologies in preschool settings existed before the pandemic.
- Online teaching can support students' learning, but few studies have examined technology integration for preschoolers at home during a pandemic.

What this paper adds

- This paper adds new data on schooling during a pandemic. During the closures, preschool teachers applied two major online teaching approaches: (a) digital content interaction and (b) online human interaction.
- Technology integration was added to provide evidence of how teachers applied online learning resources for young children during COVID-19.
- During closures, teachers often delivered learning resources via digital-mediated learning platforms, but they were less likely than other educators to expect online teaching in the future.
- Educators who perceived greater engagement of children or support from parents were more likely to expect online teaching in the future.

Implications for practice and/or policy

- This study showed that some preschool teachers integrated technology into their teaching during a pandemic, and future studies can explore how to facilitate or extend this integration after the pandemic.
- This study showed the need for more interactive online teaching preparation to address young children's learning needs.
- Some teachers were responsive to feedback from children and monitored their learning during the online teaching process.

INTRODUCTION

To prevent the spread of COVID-19, 173 countries or regions including Hong Kong temporarily closed many preschools, schools and universities, affecting 85% of students worldwide (UNESCO, 2020). During these school suspensions, many preschool educators integrated technologies into online lessons for their children (Hodges et al., 2020). Some educators tried to replicate their traditional classes via video conferencing software (ie, *Zoom*; Lederman, 2020a, 2020b). However, many educators reported inadequate preparation, training and support for their online teaching (Trust & Whalen, 2020). Thus, this study examined 1035 Hong Kong preschool educators' perceptions of their online teaching experiences during school suspensions, and their expectations of future online teaching, and perceived parent acceptance of this method via a *multilevel, mixed response analysis* (Goldstein, 2011) and *thematic analysis* (Braun & Clarke, 2006).

Online teaching in early childhood education

Different models of online learning have considered which pedagogical approaches and technologies are most suitable for children's learning needs. Compared with students in higher grades, preschool students typically engage in more play-based activities with few independent activities with computers (Huber et al., 2016). Hence, effective, online preschool teaching must consider the age of students to design tasks that maximize their learning.

Graham et al. (2017) identified four types of interactions during online teaching; online human interaction, digital content interaction, in-person interaction and non-digital interaction. During COVID-19, educators seldom used in-person interaction (Trikoilis & Papanastasiou, 2020). Without regular face-to-face classroom practice, educators created contexts for parents to use mixed types of interactions at home to help their children engage in learning activities (Apriyanti, 2020). Accordingly, we focused on online human interaction, digital content interaction, as well as non-digital content interaction because all three approaches were prevalent in educator–child interactions during the pandemic period in Hong Kong (see Table 1).

Online human interaction

Educators can interact online with students and facilitate meaningful online interactions between/among students (Graham et al., 2017). Specifically, they can use video conferencing platforms to communicate with their students in real time, and online platforms can offer learning opportunities with fewer time or location constraints (Mirau, 2017; Mitchell et al., 2020).

In early childhood (EC) education, teachers often used ZOOM during online learning to interact with the students in their classes. Because of short attention spans (Kim, 2020) and the desire to protect children's health (Student Health Service, 2014), ZOOM learning in EC education was often limited to 20 or 30 min per session (Szente, 2020). Indeed, many educators believe that children need to be immersed in real-life and hands-on learning experiences to enhance their cognitive development (Rushton, 2011). For example, in one study, a teacher reported inviting her students to find daily-life materials (plastic boxes, bowls) for making sounds and then played them like instruments in her online class (Kim, 2020). Szente (2020) also observed a teacher using ZOOM to organize a virtual class, in which children could share their real-life experiences and learning by discussing the days of the week, the weather and what they enjoyed doing in a day or over the course of a week. To support

TABLE 1 Three types of interactions (modified from Graham et al., 2019)

Types of interactions	Role of technology	Features	Example
Online human interaction	Technology as mediator	Real-time communication between humans: synchronous or asynchronous (Pulham & Graham, 2018)	ZOOM class Google meets Microsoft meetings
Digital content interaction	Platform to display learning content (Vahidy, 2019)	Working with digital resources and learning content (Pulham & Graham, 2018)	Google classroom Moodle SeeSaw School-based platform
Non-digital content interaction	Technology as a tool to upload students' non-digital learning content	Physical course content and learning materials (Graham et al., 2019)	Upload worksheet through learning platform (ie, Moodle)

children's positive engagement in online learning (Borup et al., 2020) and maintain their physical development (ECA, 2018), teachers made their online classes more interactive via music time, singing and dancing with the children, and story time. By participating in these activities, these children enhanced their learning online (Szente, 2020).

Digital content interaction

Educators can use digital resources and content to design learning scenarios for their students. Digital content includes uploading videos, photos or materials for learning activities to share with parents or teachers (Aisyah et al., 2020). Educators often prepared learning resources on an online learning platform (OLP) and required children to access the digital resources appropriate for their learning content. Taylor and Boyer (2020) showed how EC teachers uploaded and shared learning resources, such as pictures, videos and shareable links, to online platforms before or after each online lesson. Then, children accessed and used the resources and then shared and commented on their experiences by asking questions and providing explanations on the platforms. Such activities help build the connection between home and school.

An OLP is a space or portal that has educational content and/or live instruction for online learning experiences. They provide easy-to-use learning tools, a collaborative and interactive forum for both teacher and students, and a flexible teaching space (Ahmad & Ahmad, 2020; Okmawati, 2020). This type of learning platform includes Google Classroom, ClassDoJo, and Seesaw (Bacher-Hicks et al., 2020). Another type of OLP organizes educational (digital) resources (eg, cartoons, TV programs, educational videos, e-books, songs), and teachers can upload their own learning materials. These OLPs provide online opportunities for children and parents to use outside of school. Thus, OLPs offer many curricular resources (Thai & Ponciano, 2016) and can help educators build learning communities (Holland & Muilenburg, 2011). In this study, the term OLP refers to some commercial online platforms, which are widely used in Hong Kong kindergartens, including existing digital learning contents and learning spaces for uploading learning resources. As Leung (2012) noted in a previous study, 63% of private kindergartens and child-care centres in Hong Kong used OLPs before COVID-19, and they are still popular platforms.

Non-digital content interaction

After the online teaching session, educators may require students to do follow-up non-digital, hands-on learning activities, which help them understand new concepts (Hong & Diamond, 2012) and develop new skills (Bairaktarova et al., 2011). After completing these learning tasks, they can upload them (eg, report, worksheet) via their dedicated OLP.

Many preschool educators' traditional education beliefs conflicted with the integration of technologies into play-based teaching practices, so their appropriate use remains a subject under debate (Hatzigianni & Kalaitzidis, 2018). Studies have shown that children's overuse of digital or online resources, may cause impaired vision (ECA, 2018), hearing problems (Student Health Service, 2014), obesity or low bone strength (McVeigh et al., 2016a, 2016b) and negative emotional development (Boyd, 2014). Furthermore, some children may be exposed to unsafe online resources (Dickson et al., 2018). As the stimuli of real-life experiences are often superior to online experiences, the latter can be difficult for very young children to use without significant parent support (Barr, 2013).

Conversely, the appropriate use of online learning can benefit young children by providing more diverse and richer learning opportunities (Dickson et al., 2018; Prizant-Passal et al., 2016; Seabrook et al., 2016), such as promoting their language development (Neumann & Neumann, 2013). Furthermore, parents and children who use digital resources (ie, images, videos or online activities) to share positive online experiences can improve their relationships (Takeuchi & Stevens, 2011). Likewise, online learning with peers and a teacher in an online forum can help young children improve their communication skills, and sharing their learning and daily experiences may help maintain or strengthen school-home relationships and social relationships among peers and teachers (Borup et al., 2020; Taylor & Boyer, 2020).

Therefore, appropriate online learning for young children must take into consideration their age, developmental needs, online safety and environmental and health issues. For example, the Council on Communications and Media (2011) stated that children should not be able to access unsuitable content from online resources. This content includes violence, sexualized images, damaging, harmful or disrespectful elements. Furthermore, National Association for the Education of Young Children (NAEYC) and Fred Rogers Center for Early Learning and Children's Media (FRC) (2012) indicated that educators and parents have a responsibility to ensure that children are using technology in a healthy way to foster their cognitive, social, emotional, physical and linguistic development. Early Childhood Australia (ECA, 2018) has also argued that children need regular breaks and visual distancing to minimize the harm of screen glare.

Furthermore, EC educators may lack adequate online teaching skills (Hrastinski et al., 2018), making it difficult to engage their young students online. Many preschool educators felt that they lacked adequate online training, so they were reluctant to use technology (Blackwell et al., 2013; Hu & Yelland, 2017; Plowman et al., 2010). Unlike higher grade levels, EC education guidelines lack advice on integrating technologies into the curriculum or recommendations of online pedagogical activities (Hu & Yelland, 2019). Furthermore, preschools had limited opportunities to adopt online learning during their daily practice before COVID-19 (Dong et al., 2020).

Notably, preschool teachers may have difficulty engaging young students online (Doo et al., 2019). Unlike physical classes, online teaching reduces a teacher's *social presence* (Richardson et al., 2017) and interaction capacity, which hinders classroom management. Hence, online teachers were most concerned about online classroom management (Jong, 2016).

Research questions

In this study, we sought to understand preschool educators' perceptions and practices in Hong Kong during a pandemic—when the government closed all schools but expected children to continue learning. Specifically, we address the following questions:

1. What types of online teaching approaches did educators use during the school suspension period caused by the COVID-19 pandemic?
2. What factors were linked to preschool educators' views of online teaching in the future?
3. What factors were linked to the perceived parental acceptance of online teaching?

METHOD

Hong Kong context

In February 2020, Education Bureau (EDB, 2020a) of Hong Kong announced that due to the COVID-19 situation, all kindergartens should suspend face-to-face classes 'without suspending learning'. From February to September 2020, almost all EC education services applied blended learning approaches under EDB guidance, but they developed and implemented their own online blended learning models according to their context-specific conditions (EDB, 2020a). (Hong Kong's policy changed after this study, see Appendix A1: Postscript). The government's *Free Quality Kindergarten Education Scheme* supports the cost of children's tuition at 96% of preschools/kindergartens in Hong Kong (EDB, 2017). In exchange for government funds, these schools must follow a curriculum guide, which does not include technology integration. Almost all children between 3 and 6 years of age are enrolled in EC education services (eg, kindergartens, child-care centre, preschools, and combined kindergarten–child-care centres EDB, 2020b). In this study, we refer to all of them as 'preschool'. We conducted our study during June to July 2020.

Participants

A total of 1035 educators participated in this online survey. Most of the participants in the study were female (98%), and 94% of them worked in schools that participated in the Free Quality Kindergarten Education Scheme. The school size of these participants varied (more than 400 children: 21%; 200–400 children: 26%; 100–200 children: 44%; fewer than 100 children: 9%). Most participants had more than 10 years of teaching experience and had a good understanding of the EC education sector in Hong Kong. Their education levels varied (Bachelor degree: 50%; Higher Diploma/Certificate in Early Childhood Education: 38%; Master of Education: 5%; Qualified Kindergarten Teacher Qualification: 5%; Postgraduate Diploma in Education: 4%; not reported: 2%). Most of the participants were teachers (76%), with some principals (10%), teaching assistants (8%), deputy principals (1%) and others (7%). The participants taught children in K1 (3–4 years old, 29%), K2 (4–5 years old, 30%), K3 (5–6 years old, 33%) and nursery classes (2–3 years old, 9%). See Table 2 for demographic details.

Survey

Our online survey asked participants to report their perceptions and practice of online teaching during the COVID-19 suspension of Hong Kong preschools. The design of survey

involved reviewing the technical report of SITE 2006 (Carstens & Pelgrum, 2009) and relevant literature that reports on surveys related to technology used in Hong Kong preschools and online teaching in the pandemic period (eg, Dong et al., 2020; Leung, 2012). The survey had 24 closed questions and 3 open-ended questions. In the first part, eight questions were asked about participants' demographic details (gender, years of teaching, qualifications, position, teaching class/grade levels) and their preschools (name, type of school and number of children). In the second part, thirteen questions were asked about their online teaching background and experience (years, types of online teaching, activity content designs, technology used, online teaching methods, frequency, online lesson duration, extended home learning tasks). In the third part, three closed questions and three open-ended questions were asked about the challenges they faced in implementing online teaching. Specifically, the open-ended questions were as follows: (a) What are the comments from parents about online teaching? (b) What difficulties do educators face during online teaching? (c) Other comments?

Procedure

We recruited participants by emailing invitation letters to all preschools. After reading an explanation of our study, the participants gave their informed consent and completed a Google Form survey (the survey questions were attached in the Appendix A2). Participants were informed that they could withdraw their participation at any time without any reason and without any consequences.

Statistical analysis

Analytic issues and statistics strategies

Suitable analyses of these data needed to address issues involving missing data, outcomes, and explanatory variables (see Table 3). As *missing data* can bias results, reduce estimation efficiency, or complicate data analyses, we estimated the missing data with *Markov Chain Monte Carlo multiple imputation*, which outperforms *listwise deletion*, *pairwise deletion*, *mean substitution* and *simple imputation* according to computer simulations (Peugh & Enders, 2004).

Outcome issues included differences across schools (*nested data*), discrete outcomes and multiple types of outcomes. As educators in the same school are more likely to have similar responses than those in different schools (*nested data*), an ordinary least squares regression would underestimate the *standard errors*, so use a *multilevel analysis* was used instead (Goldstein, 2011; also known as *hierarchical linear modelling*, Bryk & Raudenbush, 1992).

For discrete outcomes (ie, expect or not expect future online preschool teaching), ordinary least squares regressions can bias the standard errors, so a *Logit regression* (Kennedy, 2008) was used. To aid in understanding these results, we reported the *odds ratio* of the regression coefficient, that is, the percentage increase or decrease in the likelihood of the outcome (Kennedy, 2008).

Multiple outcomes can have correlated residuals that underestimate standard errors, which we addressed via a *mixed-response* model (Goldstein, 2011). Explanatory variable issues include indirect mediation effects, cross-level interactions, many hypotheses' false positives, effect size comparisons and robustness. Separate, single-level tests of indirect mediation effects on nested data can bias results, so we tested for multilevel mediation effects with a *multilevel M-test* (MacKinnon et al., 2004). With nested data, incorrectly

TABLE 2 Background information of the participants

Participant	Groups	N (%)
Gender	Female	1014 (98)
	Male	21 (2)
School size	>400 Students	36 (21)
	200–400 Students	43 (26)
	100–200 Students	75 (44)
	<100 Students	15 (9)
Educational level	Higher Diploma/Certificate in Early Childhood Education (CE(ECE)/HD(ECE))	391 (38)
	Qualified Kindergarten Teacher Qualification (QKT)	37 (4)
	Postgraduate Diploma in Education Qualification (PGDE)	20 (2)
	Bachelor Degree	516 (50)
	Master of Education Degree	54 (5)
	No mention	17 (2)
Position	Deputy principal	5 (1)
	Principal	100 (10)
	Teacher	782 (76)
	Teaching assistant	80 (8)
	Others	68 (7)
Teaching class level	Nursery (2–3 years old)	94 (9)
	K1 (3–4 years old)	297 (29)
	K2 (4–5 years old)	304 (29)
	K3 (5–6 years old)	340 (33)

modelling interaction effects across levels (ie, educator gender \times school funding) can bias the results, so a *random effects* model was implemented (Goldstein, 2011). If the regression coefficient of an explanatory variable (ie, $\beta_{yvj} = \beta_{yv0} + f_{yvj}$) differed significantly across levels ($f_{yvj} \neq 0?$), then *cross-level moderation* may exist. In this case, we modelled the regression coefficient with structural variables (ie, school funding).

As testing many hypotheses increases the possibility of a *false positive*, we reduced its likelihood via the *two-stage linear step-up procedure*, which outperformed 13 other methods in computer simulations (Benjamini et al., 2006). When testing whether the effect sizes of explanatory variables differed, *Wald* and *likelihood ratio* tests do not apply at boundary points. Hence, we used *Lagrange multiplier tests*, which apply to the entire data set and show greater statistical power than *Wald* or *likelihood ratio* tests for small deviations from the null hypothesis (Bertsekas, 2014).

Lastly, we tested whether the results remained stable despite minor changes in the data or analyses (*robustness*, Kennedy, 2008). As a mis-specified equation for any outcome in a multivariate outcome model can introduce errors in otherwise correctly specified equations, we modelled each outcome variable separately. Next, we ran subsets of the data separately. Then, the analyses were repeated for the original, unestimated data.

TABLE 3 Statistics strategies to address each analytic difficulty

Analytic difficulty	Statistics strategy
Data set	
• Missing data (01??10011)	• Markov Chain Monte Carlo multiple imputation (Peugh & Enders, 2004)
Outcome variables	
• Nested data (teachers within schools)	• Multilevel analysis (aka Hierarchical linear modeling) (Goldstein, 2011)
• Discrete variable (yes/no)	• Logit/Probit and odds ratios (Kennedy, 2008)
• Multiple types of outcomes (Y_1, Y_2, \dots)	• Mixed response model (Goldstein, 2011)
Explanatory variables	
• Indirect, multilevel mediation effects ($X \rightarrow M \rightarrow Y$)	• Multilevel <i>M-test</i> (MacKinnon et al., 2004)
• Cross-level interactions (Educator gender \times school funding)	• Random effects model (Goldstein, 2011)
• Many hypotheses' false positives	• Two-stage linear step-up procedure (Benjamini et al., 2006)
• Compare effect sizes ($\beta_1 > \beta_2?$)	• Lagrange multiplier tests (Bertsekas, 2014)
• Consistency of results across data sets (Robustness)	• Separate multilevel, single-outcome models • Analyses of subsets of the data (Kennedy, 2008) • Original (not estimated) data

Explanatory model

We modelled children's outcomes in each school with a *multilevel mixed-response analysis*, beginning with a variance components model to test for significant differences at each level: educators within schools (Goldstein, 2011).

$$\text{Outcomes}_{yij} = \beta_y + e_{yij} + f_{yj} \tag{1}$$

In the vector **Outcomes**_{yij}, outcome *y* (*expect future online preschool teaching or perceives that parents accept online teaching*) of educator *i* in school *j* has a grand mean intercept β_y , with unexplained components (*residuals*) at the educator- and school levels (e_{yij}, f_{yj}).

Explanatory variables were entered in sequential sets to estimate the variance explained by each set and to test for mediation effects (Kennedy, 2008). Educator demographics existed prior to their work at a school, and school attributes can determine an educator's online experience. Their online experience can influence their current online teaching, which can affect their perceptions.

$$\begin{aligned} \text{Outcomes}_{yij} = & \beta_y + e_{yij} + f_{yj} + \beta_{yuj} \text{Demographics}_{yij} + \beta_{yuj} \text{School}_{yij} \\ & + \beta_{yvj} \text{Online_Experience}_{yij} + \beta_{ywj} \text{Online_Teaching}_{yij} \\ & + \beta_{yxi} \text{Perceptions}_{yij} + \beta_{yzi} \text{Interactions}_{yij} \end{aligned} \tag{2}$$

First, the **Demographics** (female, past education [masters, diploma, bachelors, certificate, qualification] and title [principal, deputy principal, teacher, teaching assistant]) were entered. A *nested hypothesis test* (χ^2 log likelihood) indicated whether each vector of explanatory variables was significant (Kennedy, 2008). As omitting *non-significant* isolated

variables does not cause *omitted variable bias*, they were removed to increase precision and reduce *multicollinearity* (Kennedy, 2008). Next, we entered **School** (Kindergarten Education Scheme, grade level, children in school).

Then, educator's **Online_Experience** (online training, online platform 1, online platform 2, Teams, WebEx, WhatsApp, Google, Zoom, problems [lack of multimedia resources, make multimedia resources, make online teaching resource skills, need for platform resources, no online teaching training, no online teaching tech support]) was added.

Afterwards, we added **Online_Teaching** (online teaching minutes per class, online teaching classes per year, online platform used most often [online platform 1, online platform 2, Teams, WebEx, WhatsApp, Google, Zoom], teaching live online, online teaching requires a learning activity, online lessons had home learning tasks, online activities [art, interactive, music, physical, storytelling, theme, guide homework], educator assessed children after the online lesson).

Next, we added **Educator_Perceptions** (online teaching difficulties [lack of parental support, pressure, low child engagement, online pedagogical knowledge, technical knowledge, ways to teach online] and reported parent concerns [child age, child needs, no time, inadequate parent support, poor content, family technical knowledge, online teaching harms child's well-being]). Lastly, we tested for **Interactions** among these variables.

Thematic analysis

Two coders applied thematic analysis (Braun & Clarke, 2006) to identify common themes in the participants' responses to open questions, regarding parents' comments and educators' difficulties. The educators' comments were initially coded into two broad categories: Online Human Interaction and Digital Content Interaction. The initial categories were then reorganized and sorted into themes around educators' difficulties of implementing online teaching approaches and parents' acceptance of online teaching. Three themes emerged from educators' reported difficulties: difficult to engage children, inadequate support from parents and educators' extra needs. Three themes of parent views emerged: reasons for parents to accept online learning approaches, harming a child's well-being and parents' inadequate online technical skills.

FINDINGS

Research question 1: What types of online teaching approaches did educators use during the school suspension period caused by the COVID-19 pandemic?

The educators reported using two types of online teaching approaches involving digital technologies:

1. **Digital content interaction:** Eighty-five percent of these educators reported that they mainly delivered digital content, including uploading videos. These educators used several types of online resources, including a commercial local online platform (79%), school intranet (19%), Google Classroom (4%) and YouTube (3%). They also used other online learning resources (ie, online educational games, online educational videos, and online parent–child activity designs) by loading them onto the digital-mediated learning platforms or school intranet.

2. **Online human interaction:** Fewer of these educators (16%) mainly used online human interaction to deliver teaching, including live streaming teaching for real-time communication between educator and children in a synchronous environment. Some (5%) used Zoom as a video conference tool to teach online.

Most of these educators set parent–child activities (42%) and worksheet tasks (34%) as extended home activities to supplement the online teaching. Other activities (24%) included reading tasks, hands-on activities (eg, arts and crafts, cooking), and other parent–child activities. Additionally, 79% of these educators asked parents to upload children's work to the learning platform. Furthermore, 22% of these educators assessed children after their lessons with follow-up learning tasks.

The duration of online teaching lessons varied from 15 min or less (68%), 15 to 30 min (26%), 30 to 45 min (4%), 45 to 60 min (1%) and more than 60 min (1%). The schools also expected teachers to deliver online teaching lessons at different frequencies: once a day (46%), thrice a week (8%), twice a week (9%), once a week (1%), once every two weeks (7%), once a month (2%) or had no requirement (23%). Most educators reported that their online teaching was voluntary (71%); only 29% said that their school required it.

Research question 2: What factors were linked to educators' views of future online teaching in preschools?

About half of the study respondents (53%) reported that they expected to teach preschool online in the future. Few perceived that parents would reject (10%) or strongly reject (1%) online teaching (see Table 4).

All results discussed below describe first entry into the regression, controlling for all previously included variables. Most of the differences in whether respondents expected future online teaching occurred across people (83%) rather than schools (17%; see Table 5, left column, middle).

Demographics, school, online experience, online teaching and perceptions were linked to expected online preschool teaching in the future. Compared with other respondents, teachers were less likely to expect future online preschool teaching (−41%, see Table 5, top, middle). Meanwhile, respondents at schools in the Kindergarten Education Scheme or in higher grade levels were less likely to expect future online preschool teaching (−23% or −9% respectively).

Respondents with more experience with OLPs were also more likely to expect future online preschool teaching (+16% or +33%). Likewise, respondents with superior knowledge of online teaching practices, such as those who included home learning tasks or assessed children were also more likely to expect future online preschool teaching (+13% or +11%). The inclusion of home learning tasks also mediated 15% of the link between use of a common local OLP and expected future online preschool teaching ($z = 2.42, p = 0.015$).

According to the qualitative analysis of the open-ended questions, the home learning tasks varied substantially, '*the home extended learning tasks is an assessment*' (T-254), '*upload children's work to the online platform*' (T-32), '*parents sent back children's work weekly*' (T-684) and '*complete the worksheet*' (T-250).

Perceived difficulties, such as difficulty engaging children online or inadequate support from parents, yielded lower likelihoods of expecting future online preschool teaching (−28% or −37%). The following response to an open-ended question describes the difficulty of engaging children: '*I found that online learning lacks interaction, and I cannot get children's feedback in the same way as face-to-face learning, and also I am worried that the content is not attractive. Additionally, I am not sure if they can really learn the knowledge*' (T-550).

TABLE 4 Summary statistics ($N = 1035$)

Variable	%
Expect future online teaching in preschool	53
Female	98
Master of Education Degree	5
Bachelor Degree	50
Qualified Kindergarten Teacher Qualification	4
Higher Diploma/Certificate in Early Childhood Education	38
Teacher	76
Principal	10
Deputy principal	1
Teacher assistant	8
Kindergarten Education Scheme	94
Grade level	
<i>N</i> (2–3 years old)	9
K1(3–4 years old)	29
K2 (4–5 years old)	29
K3 (5–6 years old)	33
Used a common online learning platform	56
Used Google classroom	3
Used WhatsApp the most	1
Inadequate training to teach online	50
Online teaching experience	65
Online lessons have home learning tasks	21
After online lesson, assess children	22
Perceptions	
Hard to engage children	4
Inadequate support from parents	3
Parents accept online teaching?	
Strongly reject	1
Reject	10
Neutral	53
Accept	32
Strongly accept	5
Reported parent opinions	
Online lessons affect child's well-being	3
Parent or child lack online technical skills	7

By contrast, perceived greater parent acceptance of online teaching yielded a higher likelihood of expecting future online preschool teaching (+9%). Perceived greater parent acceptance of online teaching also mediated 17% of the link between Google Classroom use and expected future online preschool teaching ($z = 3.27$, $p = 0.001$). This model accounted for more than 22% of the differences in expectations of future online preschool teaching.

The results also showed four significant interactions. Whereas other respondents with OLP experiences were more likely to expect future online preschool teaching (+26%),

teachers with experience in OLP were less likely to expect it ($-44\% = -35\% + 26\% - 35\%$; see Table 5, right column, top to middle). Teachers whose online teaching practices included home learning tasks were more likely to expect future online preschool teaching ($+4\% = -35\% + 39\%$). In schools within the Kindergarten Education Scheme, those who supported assessing children after an online lesson were more likely to expect future online preschool teaching ($+40\%$). Among respondents with difficulty engaging children, those working with children in higher grades were more likely to expect future online preschool teaching ($+3\% = 28\% - 25\%$). This model with interactions accounted for more than 27% of the variance in expectations of future online preschool teaching.

Research question 3: What factors were linked to perceived parental acceptance of online teaching?

Most educators (89%) indicated that the parents were neutral to, or accepted, online teaching, especially regarding teaching content and connecting with children. For instance, '*children can increase their learning engagement through seeing their teachers and hearing the teachers' voice during the online teaching*' (T-399), '*appreciate the school breaking the boundaries of time and space, allowing children to keep learning*' (T-924) and '*children had opportunities to share and meet their peers in Zoom*' (T-871).

Demographics, school, online experience, online teaching and perceptions were linked to perceived parental acceptance of online teaching. Most of the differences in whether respondents perceived that parents accepted online teaching occurred across people (74%) rather than schools (26%; see Table 5, left column, bottom). Unlike other respondents, teachers were less likely to perceive that parents accepted online teaching (-5%). Meanwhile, respondents who reported a lack of training to teach online were less likely to perceive that parents accepted online teaching (-3%). Notably, one educator said that limited pedagogy or online teaching experiences hindered interactive learning, '*it is difficult for children to have interaction, hands-on exploration, and learning because the ways of online teaching are very different from those of real class teaching*' (T-94) and '*It is difficult to add playful strategies in online teaching. I do not have enough experience to do it*' (T-115).

Respondents who used Google Classroom or had online teaching experience were more likely to perceive that parents accepted online teaching ($+12\%$ or $+5\%$). In contrast, those who used WhatsApp the most during online teaching ($n = 14$) were more likely to perceive that parents accepted online teaching ($+15\%$). These teachers used a common communication application (app) in Hong Kong, WhatsApp, and invited parents to get more involved to improve their children's online learning outcomes. These teachers reported three major ways of using communication apps for online learning. First, some teachers used an app to share teaching resources (eg, video, working sheets, photos). For example, a teacher reported that her school sent teaching videos to children's parents, and parents sent children's learning outcomes to teachers (T-256). Second, some teachers used an app to implement online classes, '*to have a video call with children via WhatsApp*' (T-344). Third, teachers like T-265 formed a WhatsApp group to facilitate communication with the children's relevant communities.

The support and the level of parents' participation also affected the engagement of their children during online learning. One of the educators noted, '*younger children need parental assistance, otherwise they will not take the initiative to watch the videos*' (T-923). Due to the diversity of families' conditions, parents' support for their children's learning varied widely, so schools could not simply require parents to support their children's online learning under one standard. Often, educators perceived insufficient online learning support from parents or other family members: '*parents lack digital devices and do not understand digital*

TABLE 5 Summary results of multilevel mixed-response models of educator perceptions of future online teaching in preschool and parent acceptance of online teaching

Explanatory variable	Expect future online teaching in preschool			
	No interactions		With interactions	
Teacher	-2.294 (0.236)	*** -41%	-1.741 (0.279)	*** -35%
Kindergarten Education Scheme	-0.995 (0.454)	* -23%	-0.746 (0.467)	
Grade level (<i>N</i> – K3)	-0.366 (0.084)	*** -9%	0.253 (0.242)	
Used a common online learning platform (OLP)	0.650 (0.189)	** +16%	1.132 (0.257)	*** +26%
Used Google classroom	1.587 (0.664)	* +33%	1.440 (0.653)	* +31%
Online lessons have home learning tasks	0.543 (0.207)	** +13%	0.033 (0.255)	
After online lesson, teachers assess children	0.460 (0.202)	* +11%	-0.434 (0.399)	
Perceptions				
Hard to engage children	-1.283 (0.451)	** -28%	-1.083 (0.456)	* -25%
Inadequate support from parents	-1.929 (0.630)	** -37%	-1.830 (0.588)	** -36%
Parent accept online teaching	0.383 (0.114)	** +9%	0.498 (0.119)	*** +12%
Interactions				
Teacher * common OLP			-1.737 (0.481)	*** -35%
Teacher * online lessons have home learning tasks			2.056 (0.499)	*** +39%
Kindergarten Edu. Scheme * After online lesson, assess children			2.239 (0.801)	** +40%
Grade level (<i>N</i> – K3) * Hard to engage children			1.282 (0.481)	** +28%
Variance at each level				
School (17%)	0.000		0.000	
Person (83%)	0.275		0.333	
Total variance explained	0.226		0.273	
Explanatory variable	Perceives that parents accept online teaching			
	No interactions		With interactions	
Teacher	-0.184 (0.053)	** -5%	-0.181 (0.053)	** -5%

TABLE 5 (Continued)

Explanatory variable	Perceives that parents accept online teaching			
	No interactions		With interactions	
Used Google classroom	0.488 (0.138)	*** +12%	0.488 (0.138)	*** +12%
Online teaching experience	0.188 (0.048)	*** +5%	0.187 (0.048)	*** +5%
Inadequate training to teach online	-0.132 (0.043)	** -3%	-0.131 (0.043)	** -3%
Used WhatsApp the most	0.624 (0.218)	** +15%	0.621 (0.218)	** +15%
Reported parent opinions				
Online lessons harm child's well-being	-0.479 (0.122)	*** -12%	-0.480 (0.123)	*** -12%
Family lack online technical skills	-0.303 (0.087)	*** -8%	-0.303 (0.087)	*** -8%
Variance at each level				
School (26%)	0.198		0.195	
Teacher (74%)	0.054		0.054	
Total variance explained	0.091		0.091	

*p < 0.05;; **p < 0.01;; ***p < 0.00.

technologies' (T-855), 'parents have no time to accompany children in online learning' (T-79), 'the internet speed is slow, parents cannot complete online learning tasks with children' (T-575), 'the parents provide very limited time for children to use or watch screens' (T-610) and 'without adults' support, children were not involved and leave [the online class] after a few minutes' (T-310).

According to some educators, some parents believed that online teaching could cause health problems for their children. Respondents who reported parent concerns, such as on-line lessons harming a child's well-being, or families lacking online technical skills, were less likely to believe that parents accepted online teaching (-12% or -8%). No interactions were significant. This model accounted for more than 9% of the variance in perceived parental acceptance of online teaching.

DISCUSSION

When the Hong Kong government suspended schools during the COVID-19 pandemic, a large majority of preschool educators used online teaching approaches to continue to deliver school-based learning content, often combining online learning and non-digital home learning tasks. Although only a small majority of the preschool educators expected further online teaching, few parents objected to online teaching. Demographics, school, online experience, online teaching and educator perceptions were linked to both expected future online preschool teaching and perceptions of parent acceptance of online learning. This section discusses three main findings of educators' perceptions and their suggestions for improving future online teaching and learning.

Firstly, these preschool *teachers* were less likely than other study participants (principal, deputy principal, teaching assistant) to expect online preschool teaching in the future. As Hong Kong's Kindergarten Education Curriculum Guide (Curriculum Development Council, 2017) emphasizes the core values of 'child-centredness' and 'play-based strategies', some participants viewed online teaching as lacking interaction, hands-on and playful learning opportunities for children. In addition, some teachers reported inadequate preparation time and professional development for interactive online teaching. Notably, the lockdown of COVID-19 caused a sudden shift to online teaching, whereby the teachers had little preparation time and school training to learn and use interactive online teaching approaches within the limited time. Moreover, preschools historically had barriers to integrating technologies into their teaching due to the insufficient technological resources, school support, personal experience and pedagogical skills (Hu & Yelland, 2017; Plowman et al., 2010). The online teaching in preschool may change the school vision of technology integration for young children based on experience and feedback.

Secondly, this study found that perceptions about using online platforms differed across school staff. Principals, deputy principals and teaching assistants who used OLP were more likely than others to expect online preschool teaching in the future. However, teachers who used OLP were less likely than others to expect online preschool teaching in the future. Although teacher-centred learning platform could smoothly deliver self-explanatory and easy-to-use learning content to parents (eg, videos, worksheets, e-books and other resources), its use did not provide opportunities for children to give immediate feedback to their teacher, who in turn could not easily monitor individual learning progress. Hence, these teachers valued learning platform less than other educators did. During passive learning, children use technology to receive information (MacDonald & Frank, 2016) via listening, observing or reading (Kimmons et al., 2020) and responding in limited and set formats. By contrast, technology-supported interactive learning often yields greater learning (Law et al., 2008).

Those who used Google Classroom were more likely than others to expect future online preschool teaching. As Hong Kong preschool educators are not systematically trained in using Google Classroom, the few educators who used it (3%) might be especially tech-savvy. Unlike the structured platform, Google Classroom offers educators more autonomy and flexibility to design their online teaching with online resources, including live streaming teaching (ie, Google Meet or Zoom link). Live streaming teaching can instantly connect children and their educators to enable conversations, realize interactive lessons and support active learning.

Thirdly, children's effective online learning often requires their parents' support. The home environment (especially online education technology) and parental involvement can greatly influence children's online learning (Dong et al., 2020), especially during the COVID-19 pandemic. Our findings suggest that educators connect with families to create and maintain a suitable support system for online learning, especially for young children who cannot work independently and lack sufficient operational skills to use the technologies needed for accessing information and giving feedback.

In addition to the home learning environment, parental engagement affects children's online learning at home. This finding is echoed in a new learning framework *Academic Communities of Engagement* (ACE), which identifies both the classroom community (teacher, classmates) and children's personal community as supports for their engagement (Borup et al., 2020). The personal community's informal support for children might fill the gap between their independent ability and academic outcomes. This support is especially important for the continuity of learning during the pandemic and might affect children's short-term and long-term learning. As Dawson (2012) noted, such supportive technologies can

yield academic benefits and improve relationships both between educators and children, as well as between families and schools.

LIMITATIONS

The samples for this study only included preschool educators in Hong Kong at one point in time and is not representative of all preschool settings in the world. Future studies can collect larger, representative samples across time that are more diverse (ie, from multiple countries). Furthermore, this study only includes a survey with limited qualitative data from three open-ended questions. Future studies can include in-depth interviews to investigate principals and preschool educators' expectations of future online teaching. Interview data can provide context-specific data to support educators' perceptions and further address their difficulties and needs in preparing online teaching.

CONCLUSION

COVID-19 has had significant impacts on educational systems across the world. As school closures require educators to transition to online teaching, multiple ways of using digital technologies are needed to cope with preschool children's learning through digital materials, especially the transition to online human interactions—often new experiences for EC education educators and their students. This intensive period of adopting technologies in preschools has forced changes in the preschool culture and technology integration approaches. Hence, the consideration of children's active learning and support for parents is essential for creating viable online learning communities. This study has provided some empirical data about the nature of online learning during a pandemic and noted that educators are aware of the limitations of learning online while valuing play-based pedagogies. Most educators believed that online teaching has a future in EC education.

ETHICS STATEMENT

Ethics approval to conduct this research was approved by The Education University of Hong Kong's Human Research Ethics Committee (0399). The consent forms were collected on the cover page of the online survey.

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CONFLICT OF INTEREST

This research has no conflicts of interest.

DATA AVAILABILITY STATEMENT

The ancillary analysis, data samples, coding scheme and coding procedures can be accessed by contacting the corresponding author.

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APPENDIX A

1. POSTSCRIPT

After the completion of this study, the Hong Kong Education Bureau issued a new circular memorandum:

2020c <https://applications.edb.gov.hk/circular/upload/EDBCM/EDBCM20185E.pdf>

Due to the impact of COVID-19, kindergartens (KGs) have to suspend face-to-face classes and adopt other modes to help students learn at home, so as to achieve the goal of 'Suspending Classes without Suspending Learning'. Because it is not desirable for young children to use electronic screens for a long period of time, e-learning is not suitable for KG students. In principle, real-time online teaching is also not supported at KG level. KGs should encourage children to read at home and design learning activities, which suit the abilities and interests of children. KGs may also provide guidelines and learning materials to parents according to their needs, so as to sustain children's learning interest, facilitate them to continue to develop life skills and acquire knowledge, as well as instill positive values. (p. 1, EDB, 2020c)

Given the previous government directive supporting online learning to reduce disruptions to young children's learning, this is a surprising development. A follow-up study to determine how this new directive combined with the previous one has affected preschool education in Hong Kong during this global pandemic would be useful. Understanding such changes and early childhood educators' adaptations can have important ramifications for the future design of curriculum and pedagogies for preschools in Hong Kong.

APPENDIX A

2. POSTSCRIPT

Survey on the current situation of early childhood educators' online teaching

Survey on the current situation of early childhood educators' online teaching

Part 1: Basics Information:

1. Gender: Male Female
2. Years of Teaching: <1 Year 1-5 Years 5-10 Years 10-15 Years 16-20 Years
 >20 Years
3. School District: _____
4. Teaching class level : N K1 K2 K3
5. Position: Principal Deputy principal Teacher Teacher Assistant Others : _____
6. Educational level:
 Qualified Kindergarten Teacher Qualification [QKT]
 Higher Diploma/Certificate in Early Childhood Education [CE(ECE)/HD(ECE)]
 Bachelor Degree
 Master of Education Degree
 Others : _____
7. Does your school participate in the Kindergarten Education Scheme?
 Yes No
8. How many students are in your school?
 > 400 students 200-400 students 100-200 students < 100 students

Part 2: Implementation of online teaching

9. Have you ever had online teaching experiences?
 Yes No (Go to question 15)
10. Have you participated in training related to online teaching?

Yes No

11. What resources have you used for online teaching¹? (Multiple choices)

「 OLP1 」 Teaching platform 「 OLP2 」 Teaching platform Google Classroom

「 OLP3 」 Teaching platform Zoom Others : _____(Please list)

12. Do the content provided by the above online learning platforms are sufficient to support your online teaching?

Yes No

(Please list your advice : _____)

13. What kind of resource do you use most for conducting online teaching?

14. Which method do you use for online teaching? (Multiple choices)

Live streaming teaching Self-record video Others_____

15. What types of activities applied in your online teaching? (Multiple choices)

Theme-based activity Storytelling Music activity Physical activity

Interactive activity Extended home learning activity Others_____

16. How often do you use online teaching?

1 time/day 1 time/2 days 1 time/3 days 1 time/week

1 time/2 weeks 1 time/month

17. How long for each online teaching session?

Within 15 minutes 15-30 minutes 30-45 minutes

45-60 minutes More than 60 minutes

18. Does online teaching include extended home learning tasks?

Yes No

¹ Use OLP1 to OLP3 to represent the names of the online learning platform (OLP) to avoid the potential commercial conflicts

19. Are students required to participate in online teaching?

Yes No

20. After online learning, are there any extended off-line activities?

Yes No

If yes, please select (Multiple choices):

Extended activities Worksheets Parent-child activity

Others, (Please list)

21. After online learning, does the teacher evaluate the students?

Yes No

If yes, what methods were used to record students' learning performance?

Children's online portfolio Online quiz Others_____

Part 3: Difficulties in implementing online teaching

22.Types of difficulties encountered (Multiple choices):

Create online teaching materials (e.g. photos, videos...)

Resources of video recording

Technical problem

Skills of video recording

Lack of online teaching professional training

Lack of online teaching confidence

Others_____

23.Do you think preschools will continue to apply online teaching in the future?

Yes No

List main reasons:_____

24.What do you think is the acceptance level of parents when implementing online teaching?

Strongly accept Accept Neutral Reject Strongly reject

25. What are the comments from parents about online teaching?

26. What difficulties do you face during online teaching?

27. Other comments?

— End —