

Understanding the Effects of Virtual Education on Kindergarten  
Children and the Relationships between Teachers, Parents, and  
Children During a Global Pandemic

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(ABSTRACT)

The global COVID-19 pandemic dramatically altered learning experiences for children, parents, and teachers worldwide. For very young children, the scrambled introduction of complex virtual tools as a proxy for the classroom experience has been particularly challenging. I conducted interviews with kindergarten teachers and parents with young children to better understand their experiences navigating virtual learning during a stressful time. Insights from those discussions informed the iterative design process I used to generate alternative interactive interfaces for online kindergarten instruction. In this thesis, I present findings from the interviews, the multi-stage interface design process, participant responses to the interface design, and promising directions for future work.

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(GENERAL AUDIENCE ABSTRACT)

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# Dedication

*I would like to dedicate this thesis to Burhan Chaudhry. As a college student himself during the Covid-19 pandemic, his own college experience was cut short and resulted in his education being limited to a virtual format. I hope that my work in this thesis can support the development of better virtual educational tools and help other students whose education is forced to be in a virtual environment. Thank you Burhan for being my person, and the one I can always count on. This thesis is for you.*

# Acknowledgments

I first want to thank Aisling Kelliher. She has been instrumental over the past year in helping me through my research for my thesis and being a guiding light through the storm that is the Covid-19 Pandemic. Secondly, I would also like to thank all of my teachers in college for teaching me the skills necessary to be the engineer that I am today and supply me with the skills needed to make the world a better place.

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# List of Abbreviations

BR Breakout Rooms

RC Regular Classroom

UI User Interface

VE Virtual Education

# Chapter 1

## Introduction

The COVID-19 pandemic has dramatically altered the ways that humans work, learn, distract, and entertain themselves. While the shift in routine towards online interactions is certainly challenging for adults, it also produces additional difficulties for less familiar technology users, including the elderly and young children. This past year, for many children of Kindergarten age, their first introduction to semi-formal learning involved navigating video conferencing software that was certainly not designed with this particular consumer in mind. For parents trying to work from home under already challenging conditions, the need to provide technical support for young children in addition to their other responsibilities had the propensity to greatly increase levels of familial stress. Tools such as Zoom or Microsoft Teams are designed for users who can read, recognize the meanings of icons, understand functionality hierarchies (i.e. dropdown menus), and have rudimentary problem solving skills when things go wrong. The UI layout and presentation of participants works well also in these tools for people who understand the basics of turn-taking and the concept of breakout rooms without host supervision.

For kindergarteners, one of the key objectives of their experience is to encourage the development of relationships and communication between peers, as well as recognize the authority of another adult beyond their parent(s) or primary caregiver. Being able to develop these skills is critical as this is when children first learn how to interact with other children who are not their family and began to learn the challenge of prioritizing “others” over “themselves”.

These skills, however, are hard to develop when the only way a student can interact with another student is by talking to them in a highly structured format, in a rectangular view that is not representative of the way a kindergarten classroom typically looks.

To understand more about the challenges for children, parents, and teachers in supporting kindergarten teaching and learning through screen interfaces, I conducted an online interview study with six parents of kindergarten children and four kindergarten teachers, all located in Virginia, USA. As part of the study, I also showed the participants mockup images that I created depicting alternate ways to re-imagine virtual kindergarten education experiences. My findings point to issues with the new roles required of parents and teachers alike in this novel distant situation, conflicting relationship dynamics that emerged over the course of lockdown, and some emotional familial problems that surfaced as a result of competing schedules in the combined home work/learning space.

Building on the insights from the interview studies, I created a series of interactive prototypes depicting alternative virtual experiences for kindergarten teachers and their students. I presented these interfaces to six participants to receive feedback and commentary on the proposed designs. Based on this feedback and informed by all aspects of the studies, I conclude by presenting possible design guidelines for future work.

Elements of the work in this thesis are accepted for publication at EDULEARN21, the 13th annual International Conference on Education and New Learning Technologies.

## 1.1 Method

I used a four-stage iterative design process as depicted in Figure 1.1 to accomplish the following: 1) understand some of the current effects of virtual education on young children

and the changing relationships between teachers, parents, and children; 2) create a digital prototype of a more child-oriented virtual learning interface; and 3) develop a set of general design recommendations for virtual education tools for very young children. Over the four design cycles, I interviewed key stakeholders, analyzed their responses, and developed and refined digital prototypes. My intent throughout this thesis was to always keep the stakeholders' needs at the center of the development of each design stage. My primary research goals included determining the challenges in virtual education across different dyadic relationships (teacher-child, teacher-parent, parent-child, child-child), surfacing issues generated by virtual education technologies and proposing and evaluating potential improvements to the virtual learning experience for the various stakeholders.

In the next chapter, I discuss prior work related to my thesis research and describe how my work builds on the literature and develops in new directions. In Chapter 3 I discuss my first design cycle which included a pilot study with relevant stakeholders. Chapter 4 discusses the first digital prototype created and the in-depth interviews I conducted with kindergarten teachers and parents of kindergarten students engaged in virtual education. Chapter 5 details the design refinements to the prototype based on findings from the interview studies, while Chapter 6 and 7 draws final conclusions about this work and suggestions for promising future directions.

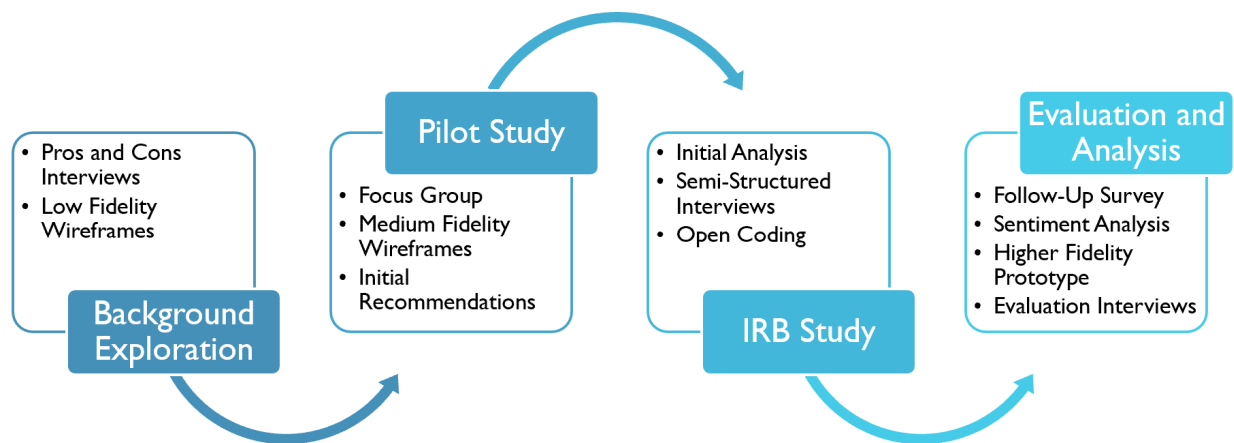


Figure 1.1: Methodology of Thesis

# Chapter 2

## Review of Literature

### 2.1 Virtual Education

Virtual Education (VE) prevalent has been a primary source of education for students across the globe for years. Australia and China utilize VE as a tool to teach and developed unique strategies to overcome physical barriers and maintain student engagement [1,3]. Engineering students in Australia who were attending local universities virtually had higher student satisfaction and reduced work for instructors by about 25 percent while the engagement level of students and grade distribution stayed the same as opposed to their in-person counterparts. [1] Understanding how VE has operated successfully in a country is vital as it proves the importance of VE in the new technological world. Engagement is a critical issue when teaching young students and if VE results in higher student satisfaction then it provides grounds to examine directly how VE is affecting the education of younger students. One technique that has great success in pre-university schools in China, is having virtual classes operate in a flipped classroom. While knowing that VE can be useful, those schools, indicate that there is not enough research to identify the best techniques nor identify how different groups of individuals learn within pre-university schools. [3] Children cannot operate at the same technical level that middle schoolers and higher education students can, so studying and identifying how these students learn can greatly benefit how VE can be better tailored to those students. While developed countries like China and Australia have benefited from

the adoption of VE, developing countries also have millions of children who lack proper education, and educating them is the next step to helping these countries grow. Much of the education in these countries is outdated and not on par with the global standards. Schools experience an increase in research produced by children in Pakistan who use VE. [2] Regardless of what state a nation is in, VE can help strengthen its youth's education promoting the countries own prosperity.

## 2.2 Study of Virtual Education

Researchers use a variety of methods to evaluate VE and identify strategies in which it can be improved. These include participatory design, graphical analysis, interviews, surveys, and metadata analysis. When studying VE, researchers tend to have a significant amount of qualitative data, and drawing effective conclusions from it can be difficult. To solve this issue researchers studying middle school students, took a more quantitative approach by creating a relational graph between teachers and students to study the level of communication between both parties and who initiated those conversations. [5] The purpose of this technique is to identify shy students and encourage them to participate more. This can be a key tool used to study Kindergarteners, as they have not developed the social skills to navigate conversations. While analyzing voice communications is effective, another group of researchers took a different quantitative approach by studying metadata in forum posts. They broke up their data by months and "content categories" - themes. They then identified any outliers or patterns to show which months or topics students ask more questions about. [6] Looking at this data provides teachers with insights into how best to teach certain topics and help students who are struggling. Looking at chat logs, rather than solely relying on participatory design provides insights sometimes overlooked as more introverted students

can still be analyzed through their non-verbal actions.

Studying the actions of the users through automated aggregated data, while useful, results in key data being lost without testimonials directly from stakeholders. When studying a group of students who were transitioning from in-person to online learning, researchers were unable to get reliable data due to the shifting forum of education and unable to use qualitative means of evaluation, they relied on participatory design and interviews to ask students about their experience and how they communicate with their teachers in the new format. Grouping the feedback to draw out novel themes, the researchers found that students found communicating with their peers and the teacher proved to be increasingly difficult. [4] Grouping feedback into categories is a common technique when researchers are analyzing their interview data. When researchers were studying 10 child care centers to try to gauge the children's responses and reactions to VE, they were grouping the responses into different "Gratifications". The gratifications included whether the children responses positively or negatively to VE and whether their educational goals were achieved or resisted by VE. [7]

Some researchers have expressed concern while getting feedback from children about their VE experience and how it might prove to be difficult and more labor-intensive, they found evaluating college students' experiences can be effectively done through surveys. Researchers tasked college students who were halfway through the semester and forced to transition from a face-to-face learning system to VE, with a set of surveys. The researchers used the surveys to draw quantitative results from the data. They also used Participatory Design (PD) to get more qualitative data from the stakeholders. [8]

Over the past 10 years, there are a few main methods of studying VE. These have been: surveys, graphs, and plots of logging/metadata, and most common, PD through interviews. These techniques supplement each other and draw as much information from the interactions that the students and teacher have. A combination of these techniques is used in this study

to specifically study children's responses and to observe how VE has affected them.

## 2.3 Improvements in Virtual Education

VE has been used across the world for over a decade, and researchers observe how it can be improved and how teachers have tried to duplicate the classroom environment over the internet. One of the first tools researchers tried to duplicate is a whiteboard experience through virtual interactions. This enables students to draw on their computers at the same time effectively as if they had expo-markers on a real whiteboard. [9] Numerous technical challenges were readily apparent; if the communication has any delay in peer-to-peer information, it deems the platform unusable, as that is not how individuals interact. Kindergartners who require significantly more attention have a lower patience tolerance for a lag in information. Kindergartners also require constant attention and for their teacher's teaching style to be a lot more stimulating rather than purely educational. This issue becomes even more apparent in distance learning as students get bored quickly and lose interest. To try to combat this, researchers thought about utilizing gamification to increase interest in education. Through surveys and participatory design, they found that engagement would benefit from a gamified system. [10] Keeping the attention of children is even more critical and difficult, so understanding if gamification is a technique that might work, could be beneficial to identifying how VE can be improved for children. Building upon this work, researchers wanted to understand what other techniques could be employed to try to help improve the education of students from all levels of primary education through college. After an extensive PD process with children, they found seven main techniques to keep the students engaged. These are Gamification, Micro Podcasts, Online Chats, Consistent Feedback, Focusing on Student's Professional Needs, Calling on the Students, and Storytelling. [11] Knowing that these tech-

niques can work, studying these specifically through the lens of children, can identify which techniques are most effective with this age group and how to best implement them.

When students are learning virtually, they lose the benefit of being physically in person and developing those relationships. The researchers specifically look at: “how to promote a sense of community with interactive visualization” to look at how video learning can increase the sense of community among the students. After interacting on virtual prototypes for what a social network might look like for education the researcher talked to teachers and students using a PD-heavy process to always keep the design focused on the needs of the student. [12] Researchers at the Michigan State University in 2014 claim that, Kindergartners are at an age when learning how to develop social connections is critical, therefore asking children about their thoughts and if they feel connected is important. While improving the VE experience itself, significant improvements need to be made to the infrastructure as researchers studying the Effects of Augmented Reality Mobile Apps on Early Childhood Education Students’ Achievement, questioned why VE is not mainstream and what are the largest hurdles the system has to overcome. They found three main areas where VE’s infrastructure could be improved. These are improvements in software and hardware environments, increasing the time in the day to study, and lastly increasing the publicity of why VE is good. [13] Not all students have the same accessibility to software and hardware to be on the same technological level as the rest of the class. Secondly, having more time in the day to study, and to study during the time you want, could be beneficial to children as not everyone learns the same way, therefore looking at these principles and how they affect children could lead to new insights.

Another aspect of a Kindergarten’s education is how they develop interactions and build social connections. Within higher education, students who want to be connected and can find ways to do so, but those connections do not translate into meaningful long-term con-

nections. While VE does reach students who like asynchronous learning, a balance needs to be made. Having more synchronous activities can stimulate connections and try to convert those connections into relationships that will go beyond academia. [14] Replicating this with children would be interesting to see if children are even able to find new avenues to stay connected and if within the avenues provided to them, they can develop new relationships.

## 2.4 Social Goals for Kindergarten Children

Studying VE in young children is important and to understand how VE will affect them, it is critical to examine what social goals are expected of Kindergartners to develop. Kindergarten is primarily the first time that children interact with other adults who are not in their immediate family. This comes along with many social goals that school districts have established to ensure that children develop the proper social skills to communicate with other people. Kindergartners have to recognize the feelings and perspectives of others and acknowledge each other's similarities and differences. Kindergartners are also expected to learn how to communicate effectively with each other and resolve interpersonal conflicts. [21] These goals indicate how Kindergartners are expected to understand the complexities that arise when communicating with individuals with whom they have not grown up with.

In Kindergarten children are also expected to learn how to develop healthy relationships with their teachers and classmates. This entails not only talking with their peers but cultivating meaningful relationships and actively participating in the classroom. Other goals include the students being able to recognize each other's emotions and expressing concern in times of stress and assisting their classmates indicating a sense of connection. [22] Most of the relationships that kindergartners have had at this point in their lives are that familial and are primarily initiated by another party. In school, Kindergartners have to understand how

to cultivate these relationships on their own and initiate this behavior. [23]

Understanding this baseline of social goals that are expected of Kindergartners is important, as moving forward in the research, it will be interesting to see how VE has affected the children's ability to achieve these social goals and how an improved UI can assist.

## 2.5 Children in Virtual Education

Children have been primarily left out of the VE research. Most of the research in the past decade about VE uses PD with students in higher education. Now that many children are attempting to learn virtually and as parents are more protective of their children in a time of a pandemic, children are likely to stay home. Understanding how VE affects them is critical to ensure that the baseline of their education is not weakened due to insufficient research into identifying what techniques and tools can best help them learn.

A common misconception is not involving children in the research or the design cycle but when a classroom of students with some of their peers being disabled were studied, children were better able to identify the needs of not only themselves but any of the classmates as opposed to their teachers. A study focused on studying VR use in children saw that when improving technological systems for disabled children, the researchers were able to get information from their non-disabled classmates as they were acting as proxies. [15] To improve the VE learning experience for students with disabilities, AR/VR systems could prove to be beneficial, however, creating this immersive experience is not economically feasible. Too many resources are required to make AR/VR courseware for every topic. Enough resources would only be dedicated when the technology would be in regards to general topics used by all many students. [16]

VR has always been a contentious issue in VE due to the price of creating curriculum in such a format. While it does provide a great resource for students to learn, not every student has access to the necessary materials to allow it to work. [17] AR systems can significantly benefit the education of children as when tested with young children an AR system allows for students to learn the alphabet much faster and children have increased interest in the classroom material. [18] VR can also be supplemented with techniques alike to gamification, as it did improve the learning process. There were certainly key factors that the children wanted from their virtual systems. This included: “instructions”, “easy-to-use interface”, and a “clear color scheme”. [19] Getting these details from children is invaluable as they can better help design future systems so children do not have to be bogged down by complicated user interfaces but instead can focus on what is important to them, their education, and connecting with their classmates.

Students need to be involved in the process, but at which stage during the design cycle varies based on the research. Some believe that they should be brought in at the end to review the final product while others believe children should be heavily involved in the design process at every step, evaluated the prototypes. [20] The perspective of children need to be accounted for in the design process and as thoughts are valuable. This thesis draws conclusions from key stakeholders and their actions through a series of interviews and interactions, as well as the development of prototypes and recommendations for future VE systems developed for Kindergartners.

# Chapter 3

## Pilot Study

### 3.1 Preliminary Interviews

Following the literature review, I conducted informal interviews and discussions with potential stakeholders and/or people with experience with virtual education tools.

Six individuals were interviewed regarding their thoughts about the “pros and cons” of virtual education experiences and any suggestions they might have for improving the experience. Findings from these discussions are displayed in Figure 3.1. These interviews were conducted during October 2020, both in-person and online. Participants were screened to make sure that they had some experience with virtual education and the six participants comprised teachers, graduate students, and parents of children. The interviews lasted for five to ten minutes and were unstructured. The goal of these interviews was to gain an initial understanding of how virtual education experiences impacted different communities.

Figure 3.1 presents the key issues surfaced about virtual education tools during the interviews, with particularly noteworthy topics highlighted with a yellow outline. While some of the findings were more specific to students in college, other observations were indicative of important social issues that occur more broadly with virtual education. The issue of communication was deemed important, especially as students were less able to communicate with one another, work in groups, and/or develop meaningful relationships. For younger children,

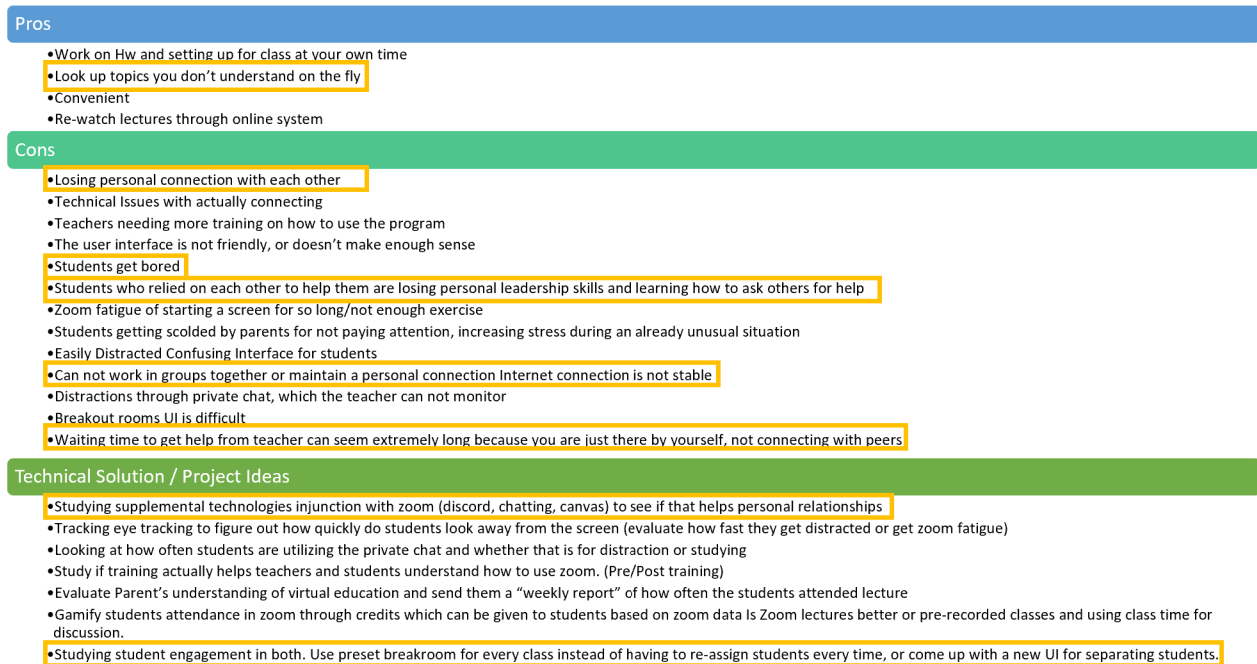


Figure 3.1: Pros/Cons and Technical Solutions, Yellow Quotes are Key Observations

the reliance on their parents for regular assistance meant that they lost out on opportunities to develop their own sense of independence. Naturally, numerous technical challenges were also discussed, but it was the social element that began to interest me most.

Insights from these informal interviews guided the design of the first iteration of the low fidelity interface. The approach for developing these rough prototypes was through simple sketching of the ideas on a piece of paper. A variety of iterations were designed with accompanying instructions on how these interfaces could operate. The purpose of this work was to generate as many ideas as possible from the initial data gathering so that later iterations could meet a broad range of potential users. Three core new design ideas were developed as a result of these sketches. These design ideas were discussed internally within the research team to identify if they had merit and then those selected to move forward were developed into a medium-fidelity format.

## 3.2 Sketch Prototypes

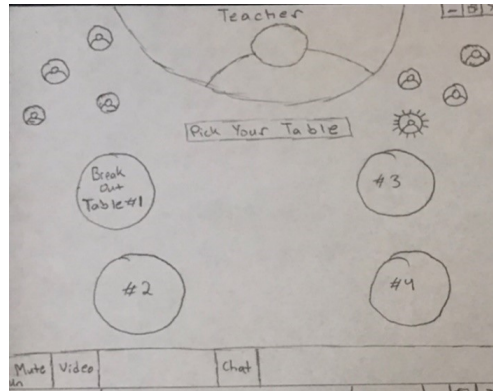


Figure 3.2: Breakout Room Selection View Hand Sketch

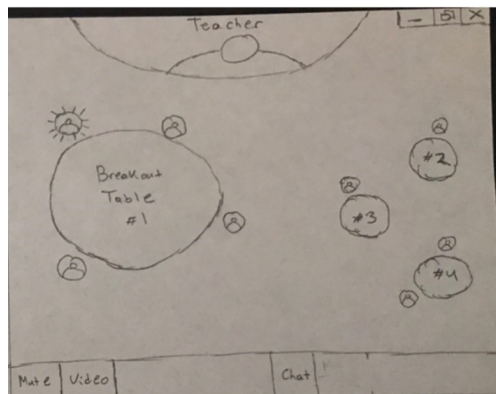


Figure 3.3: Breakout Room Table View Hand Sketch

The first interface idea, depicted in Figs 3.2 and 3.3 above, presents a new breakout room view, which rethinks the way that groups can operate in a virtual environment. The new breakout rooms would operate by having the teacher click a button and all of the students' videos would transition into circles showing their faces and those circles would move to the sides of the screen where virtual tables would appear. Students would be able to see everyone but not hear each other until they selected a table. Once students selected a table, they would be able to hear all of the other students also at that table, and their bubbles would hover around the table. Students could still see the other students' tables - the other tables

and students' videos would be smaller but still visible - but the students not at the table could not hear those students. Students would have the option to join another table, but this would be controlled by the teacher who could set time limits for students to move between tables and also set the maximum number of students at each table. Teachers could also send activities and messages to each of the tables and rotate through them. The main purpose of this interface view is so that students can see each other while only hearing the peers at their table, similar to a real-world classroom setup.

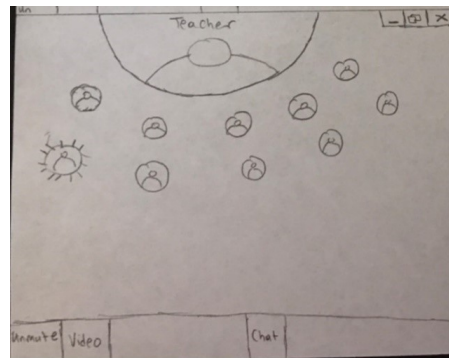


Figure 3.4: Default Classroom View Hand Sketch

Fig 3.4 presents a second view of a new regular classroom, which rethinks the way that the teacher can teach while also allowing the students to view each other. The new regular classroom setup is structured so that teachers could center their video on the screen like a “rising sun” and the students could “move around” in their circle video screens. They could use their mouse to drag themselves around the classroom or the teacher. The students would be able to see everyone else in the classroom and selectively unmute themselves to speak or perhaps do so only at the discretion of the teacher. This new setup allows for increased visibility for all the students and the teachers as well as replicating how kindergarteners might typically navigate a physical classroom environment.

The final interface concept is presented in Figure 3.5 and shows a free time view, which offers a new way for the students to talk and hang out with each other with minimal supervision,

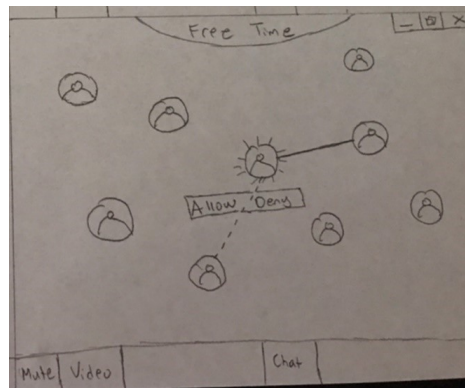


Figure 3.5: Free Time View Hand Sketch

thus mimicking playtime in the classroom. Students' video circles would float around the screen and they would be able to click on another student and a "line" would show up between them so that the pair would be able to hear each other but no one else. Other students could join by clicking one of the other students and the "students already talking" would receive a small pop up indicating that someone else wanted to join. The students could then allow one of their friends to join their conversation, connecting their audio to the new student who wants to join. The students would also be allowed to leave the call. The purpose of this interface view would be to give the students themselves the choice of who to talk to and for how long.

### 3.3 Design Refinements

Following the creation of the low fidelity wireframes and the initial review from the research team, I created medium-fidelity models using MockFlow. These models replicated what the new user interface would look like and feel like, and with varying levels of prototype interactivity. There were two major new ideas addressed in this format. The first being new "Breakout Tables" and the second being a new "Regular Classroom" set-up. I added

additional features to reflect feedback from the research team. Once the medium fidelity wireframes were developed, I presented them to a group of graduate students and conducted informal interviews and observations as the participants navigated through the prototypes. 14 participants assisted with this part of the work, which helped identify important themes and issues to consider. Currently we are in the pilot study phase of Figure 1.1.

The first refined interface idea concerned the breakout rooms. This idea originated based on complications identified with breakout rooms in current virtual software platforms, such as Zoom. In this breakout room user interface (UI), the students could click on the table that they wanted to join. Once added, they would only be able to hear the other students at the table, but they would still be able to see all of the other students in the room.

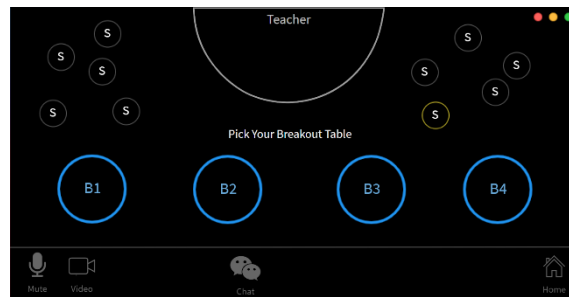


Figure 3.6: Breakout Room Selection View Mockflow

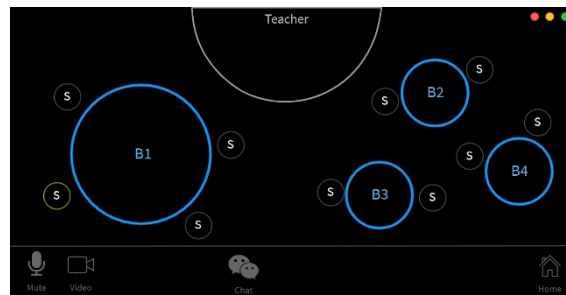


Figure 3.7: Breakout Room Table View Mockflow

The second redesign refers to the regular classroom set-up. The idea here was to replicate how children “sit around” a teacher in the physical classroom while still being able to view all of the other students.

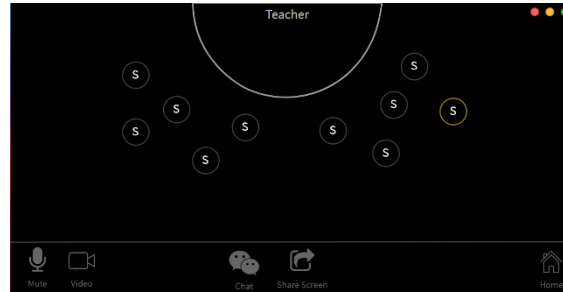


Figure 3.8: RC View Mockflow

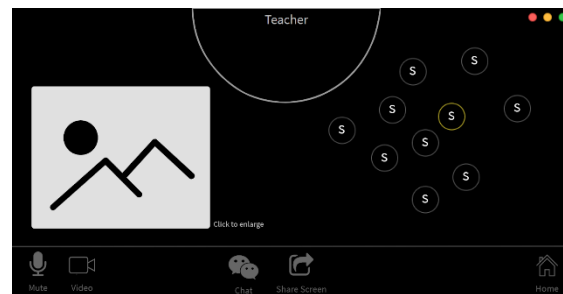


Figure 3.9: RC Share Screen Mockflow

These wireframes can be accessible at the following link: <https://bit.ly/3fZNQpF>

## 3.4 Ideation and Brainstorming

The 14 informal interviews conducted regarding the medium-fidelity wireframes generated seven key themes: Control, Child-Friendly Design, Understandable Text, Improved UI, Automated Tracking, Increased Interaction, Involving Parents. Below is the summarized feedback with each of the themes. The results of the quotes are displayed in Figure 3.7 and 3.8.

Control emerged as an important factor when dealing with young children. Typically, when given the opportunity, young children are likely to “play around” with the software and make it into a game. Therefore, limiting the table selection for when students are picking their breakout table would allow students to stay focused. This could function through the teacher limiting how often a student can switch between tables or limiting how many students are

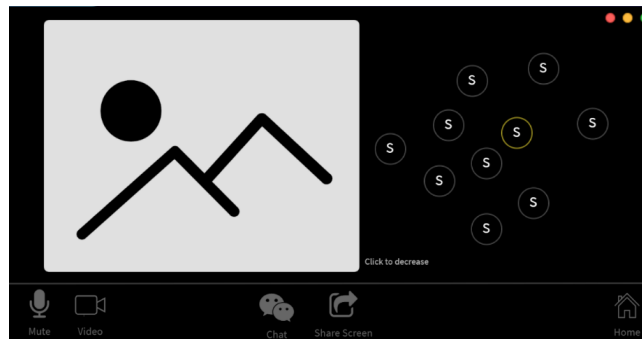


Figure 3.10: RC Large Share Screen Mockflow

#### Control

- “I think having a “cooldown” for moving could potentially prevent kids from randomly jumping around.”
- “limit number of kids at a table and maybe something that stops them from button spamming clicking between tables”
- “slow down the movement”
- “Adding more control for teachers”

#### Child-Friendly Design

- “Really like your design of using classroom and tables as a metaphor.”
- “As it is designed for kids, the UIs could be more cartoon-ish too, maybe have the classroom be a lake and the table is boats. The children could have cartoon avatars.”
- “More friendly background, all black/zoom application background is boring and not appealing to children”
- “Include a little AI helper cartoon which can give them advice or help if they need something”
- “Nice to see everyone at once”

#### Child-Friendly Design Cont.

- “Students bring in their bitmoji or online avatar (gamify by attendance)”
- “Name the tables and change the theme and look of the table so that students have more personalization (zebra, unicorn, rocket table)”
- “Give virtual stickers attached to the video of the student to encourage them”
- “Drawman (hangman but “drawman” more child friendly) - build an interface to support that game”
- “Build more child teaching game interfaces in general”

#### Understandable Text

- “Breakout Tables – sounds weird to me, I would change the name.”
- “Drawman (hangman but “drawman” more child friendly”

Figure 3.11: Pilot Study Quotes

at a table.

Creating a child-friendly design is the second emergent theme. Suggestions for improving the UI revolved around making it more friendly for children which could entail altering a boring black background into something more colorful and inviting, as per typical kindergarten classrooms. Stickers or a reward system could be put in place so that students could see each other’s achievements and collect stickers over time which they could show to each other. Other ideas were to make the actual tables themselves have themes and virtual pictures associated with them so that children could say that they were going to the “zebra” table for

**Improved UI**

- “Your table should be in the center of tables should stay in place.”
- “Have the children images overlay in a corner of the screen but move around when viewing shared screen”
- “Increase the size of videos a lot of dead space”
- “Bathroom button - students can press the button instead of having to wait for the teacher to call on them - gets muted and the video turns off - when unpressed turns them on again”
- “Virtual whiteboard so that all of the kids can write on there at the same time”
- “Make a virtual library (breakout room) or a virtual computer lab (breakroom room) - change “virtual location”

**Automated Tracking**

- “Track which students are participating, feature for teacher --- automatically group students who talk less with students who talk more in the group to stimulate conversation”

**Increased Interaction**

- “Have a way for students to display their answers on screen at the same time - the virtual mini whiteboard. Chat doesn’t work since it is all clustered and old answers go away”
- “Children get distracted, require them to press a button every 5 min”
- “Blackboard showing what all of the students say (smartboard with answers to a question a teacher asked with what each student responded)”
- “Raise hand function is displayed on the screen and not only on the sidebar so all of the students can see who raised hands (mimicking in person)”
- “Give tasks to all of the students to encourage them to participate (increase responsibility)/give students a friendly online survey (within the application)”

**Involving Parents**

- “Build google docs plugin into zoom or what they are using to have “virtual books” so kids can access it within “zoom” and parents can access files”
- “Parents have trouble with printing - draw virtually inside application instead”
- “Virtual checklist for all of the students, that parent, child (only the child itself not every kid), and teacher can see on the virtual platform”

Figure 3.12: Pilot Study Quotes Cont.

example instead of breakout table 1. This was a point brought up by multiple individuals about how the UI needs to be engaging and interesting to the children. A large reason why children are not able to focus is the repetitiveness and “zoom fatigue” that occurs from staring at a mundane screen for extended periods of time. Another way to improve the UI would be to gamify the different activities. .

Layout improvements were also suggested during the interviews. Most of these involved re-sizing components so “dead” space on the screen would be usable. A new feature suggested was to add a “Bathroom Button” which would allow for the student to just click it and notify the teachers that they had to go to the bathroom. While this may seem unusual, for young children, these are still things that you need to teach, and at times it is difficult to have to pause the entire zoom lesson so a student can leave to go to the bathroom thus disrupting the flow of the class. This is an indication of how we could leverage the new virtual environment to create a system to streamline class interactions with fewer distractions. Another suggestion made was to make the UI look like the virtual students were virtually going to different places in the school, such as a library room or the music room. This change in the

online environment would help stimulate the mind and possibly reduce boredom levels.

Using technology to help streamline the classroom activities lead to the idea of having the teacher be able to track and appropriately assign students to different groups based on their interactions with each other and how vocal they are. In the classroom, it might be difficult to monitor every student and how much they are participating but online you can have the system track that for the teacher for them to review at a later time.

When dealing with young children, there is also a strong element of entertainment required on the part of the teacher. Young children tend to lose attention quite quickly, therefore some ideas generated were that students could be directed to press a button every few minutes to keep them engaged. Other ideas involved having the students interact through raising their hands or answering a question by typing their answer. This would be to stimulate the screen itself and keep the children's attention on the screen without having them lose focus.

The final emergent theme related to the importance of involving parents in virtual interactions. A collection of the responses boiled down to have the UI contain a program similar to google docs where the teacher and students could load the proper assignments and work that they are doing in class. This would resolve the problem of having parents and children forced to use multiple applications to attend class and almost create a "hub" that the students could use. Involving parents and making the UI easy and intuitive for them is also critical since they are balancing a lot of responsibilities on their shoulders and simplifying the UI so it can be a "one-stop-shop" for all of their children's needs can help ease the load for everyone involved.

# Chapter 4

## Understanding the Experience of Teachers, Parents and Children Engaged in Virtual Kindergarten Learning

### 4.1 Qualitative Interviews

In Spring 2021, I conducted semi-structured interviews with six parents of kindergarten students and four kindergarten teachers. The interview study protocol was approved by the Institutional Review Board at Virginia Tech. The purpose of this study was to 1) better understand how young children (ages 4 – 6) were adapting to learning in Virtual Environments; 2) examine the impact that this teaching and learning modality was having on families during a global pandemic; and 3) better understand the relationships and communications between parents and teachers during a global pandemic. The eligibility requirements for the study were as follows: 1) parent of a child aged between 4 – 6 years old who had received virtual school instruction OR kindergarten teacher who had delivered virtual school instruction 2) be between 18 - 85 years of age; and 3) be proficient in written and spoken English. I identified and recruited subjects by snowball/word of mouth over email. Subjects

were recruited from the Fairfax school district (the local Montgomery school district was not allowing studies with teachers, students, or parents during the pandemic). Figure 4.1. presents the demographic information of the study participants.

PID	Role	Age	Children in Kindergarten	Interview Duration	Job
P1	Parent	48	2	30:18 min	Business Consultant
P2	Parent	44	1	43:33 min	Microsoft Developer
P3	Parent	44	2	28:02 min	Photographer
P4	Parent	42	1	34:04 min	Stay at Home
P5	Parent	37	1	29:19 min	2nd Grade Teacher
P6	Parent	34	1	26:16 min	High School Teacher
P7	Teacher	51	1	44:40 min	Kindergarten
P8	Teacher	44	0	28:50 min	Kindergarten
P9	Teacher	45	0	16:06 min	Kindergarten
P10	Teacher	48	0	42:10 min	Kindergarten

Figure 4.1: Demographics of Interviewees

During the interview, participants were asked a series of questions in a semi-structured interview format. Topics covered included determining morning routines pre-school, work/life balance, relationships between families and teachers, and overall challenges encountered with learning experiences during this difficult time. At the end of the interview, the participants were presented with the high fidelity prototype designs and asked for their opinion. The interviews were conducted over Zoom, recorded with permission, and then automatically transcribed. I analyzed the transcripts using a process of open coding, working with another member of the research team in labeling two of the transcripts. Following discussions, we developed a list of codes that I used to label the remainder of the transcripts. The team worked together to distill the codes into primary themes. The six primary identified themes are presented in Figure 4.2.

## 4.2 Negative Effects on Student Learning Experience

The parents in our study reported two primary issues with their kindergarten children's experience with online learning. The first concern was that expressed misgivings about how other student's actions in the virtual classroom were negatively affecting their own child's education and how interactions with their teachers involved some levels of misunderstanding. A common concern from parents about other students was that they were talking over their child and they believed that their child's voice was not being heard. Teachers noted issues with trying to selectively mute students, so to keep things under control, they tended to mute everyone. This sometimes had a negative affect as noted by P2:

*"Kindergarteners sometimes will cry off the camera, because there is no way like if the teachers accidentally mute the mics", P2*

From a different visual perspective, P4 also noted her child's frustration for example:

*"My kindergartener will hold up her work, but nobody sees her. And she, in the beginning, didn't realize that no one could see her. And she kept waiting and waiting for someone to say something. But I mean, the teachers have no idea", P4*

A second concern noted and remarked on by parents and teachers alike related to the amount of assistance/help offered by parents who were now sitting alongside or near their children in the home. The parents justified their desire to assist their children (and to be seen as assisting), as noted by P4:

*"But just to double-check that they're submitting it right, they sometimes have*

*trouble. So because I double-check before submitting [increases my] visibility.”,*

*P4*

Parents noted that because they could now effectively listen in on activities in school, they were more aware of their child’s experience. Parents displayed varying reactions to this, ranging from frustration at hybrid communication modalities, to feeling overwhelmed by the amount of parent/teacher communication. For example, with the former, P5 stated:

*”Sure she’s swamped. But I mean, some of those questions don’t always get answered. So I feel like it gets missed. And then you know, she might send out a, he might address it in another form, like a few days later, it’s not to me.”, P5*

Another parent expressed interest in getting summary details about their child’s daily experience:

*”Just a summary. So I didn’t have to worry about going through, you know, 20, or however many emails.”, P1*

These concerns about child/technology interactions and parent classroom observations lead me to imagine several possible interventions. Care needs to be taken with the first issue, as when parents express concern to the teacher about the behavior of other students, this can negatively affect the relationship between the parent and teacher. It could also affect the child’s thoughts about their classmates to hear their parents express negative thoughts about their classmate’s behavior. A more nuanced muting system could assist here to reduce frustration. Limiting students who are more vocal while increasing the visibility for students’ who are more introverted could be solved with a better voice control system for teachers and making students more aware of when they are muted.

To address the over-involvement of parents in assisting students, I suggest a number of possible features. The first could be a system for teachers to quietly notify the parent in real-time through a built-in messaging app which the teacher could use to tell the parent to try to let the child work on their own. This tool could also be used for parents to communicate directly with the teacher in class if they felt like their child was being silenced by other students due to the reasons stated above. By building this directly into the UI, it would allow for parents to not have the stress of dealing with another application and to communicate with short in application responses instead of a message being buried in an email inbox where it might go unread. Another technique could be for the UI to show the agenda, created by the teacher and for a summary to automatically be emailed to parents at the end of the day. This way the parents would know what their child did that day without having to sit next to them the entire day.

### 4.3 New Roles for Parents and Teachers

It became apparent during our interviews that parents and teachers are being forced into new roles that they do not necessarily have the training for or do not know how to complete, resulting in stress. The first is that parents are being forced into the role of being a teacher. This is in large part due to asynchronous days in which teachers just give work for students to do at home without having class.

*"I'm, like, almost prepared, like, okay, Mondays, I gotta like watch over them.*

*So yeah, it's certainly a source of stress.", P1*

Parents on these days have to push their children to do work, but because the direction is coming from their parents, children rebel more owing to the parent/child dynamic.

*"If the teacher asked her to do something she didn't want to do, she would just do it. But because I'm her mom, you get more pushback.", P2*

On days when there is synchronous learning, parents have to stop what they are doing to assist the teacher in getting their child to focus and pay attention if their child does not want to, which takes time away from their own lives, blurring the lines between school and home.

*"And we can only prep them so much all the time. I mean, there are days where we're busy, and they don't, they don't always have they have everything.", P6*

Some ways that an improved UI could solve these issues for asynchronous days would be functionality for teachers to upload pre-recorded lecture pieces for their students to listen to on their own time. These could entail a group of videos that the student or parent could play as the child completes the different activities mimicking a synchronous day of learning. Another feature that would assist parents in this new role would be on asynchronous days for the UI to still work with an additional free time online environment. A free time view could offer a new way for the students to talk and hang out with each other with minimal supervision, allowing for a system to mimic playtime in the classroom. This view would allow students to talk to other students on asynchronous days, asking for help on assignments or just conversing – both of which would ease the load that parents have to endure on those days.

From the teachers perspective, several noted that they were acting more like therapists for parents and less as teachers for their children. Teachers expressed frustration about having to have long virtual conversations with parents about how they should be raising their children, which they felt was placing a burden on them to direct the parents on how they

should act with their children, particularly with regards to teaching certain assignments on asynchronous days.

*"The mom can't be sitting next to her for the rest of her life, holding her hand making sure to pay attention in class. Right? Like she's got to develop those skills on her own.", P8*

This forces teachers to not only have to create a curriculum and resources for teaching the kids but also gather resources for parents. While an improved prototype could fix some issues that exist in virtual education, this increased responsibility is not as easy to fix. Teachers could be given training on how to counsel parents but that will not solve the issue of increased expectations that parents have from them. I find that some issues cannot be completely solved by a prototype and are unavoidable challenges that come with virtual education.

## 4.4 Tensions between Parents and Teachers

During the interviews, the teachers described growing tensions with parents over the course of the pandemic. The believed that some of the parents gave the impression that they thought the teachers weren't doing enough, but weren't coming out directly and saying that. P7 described how they thought there were misunderstandings between parents and teachers because:

*"And people [Parents] like can misread your tone and stuff like that.", P7*

While acknowledging the stresses everyone was going through, the teachers described the

tensions between trying to support the children with independent learning, but also helping the parents to support their children. This issues was noted by P10 who stated:

*"So some of the work isn't as authentic on their own, because the parents are like, spelling everything for them, or they're just not independent.", P10*

Several of the parents acknowledged this directly, with P4 saying:

*"I double-check all their work. ", P4*

In response, the virtual education platform could be improved by making accounts for parents and incorporating them into the classroom environment. Every week, if the parent chooses to, one parent could lead a book reading or a virtual activity in their online module for the class. The purpose of this would be to show the amount of work that goes into handling 20 to 30 students virtually. This would be different than the teacher just describing the work because many times parents might not understand until they experience the pressures that teachers experience. Another tool that the prototype could have is to generate a transcript of the class and at the end of the day it would get sent to the parents so they would have a direct and more convenient report of what happened in class. This would also support the teachers in their efforts to explain to parents what they are doing every day and why their increased 1:1 conversation with their children might not be as easy as it seems.

## 4.5 Familial Conflicts

The interviews surfaced several interpersonal family conflict situations that may be beyond the abilities for a technology to solve. Parents who were working full-time outside of the

house before the pandemic seemed more accepting about the fact that things would get messy with everyone being at home and that organizing efforts might not always work out. They also described a higher level of tolerance with regards to children 'acting out' at home, as opposed to parents who worked in or from the home prior to lockdown.

Issues of productivity and/or unfair distribution of workloads were also described. P5 described how everyone was really losing out as:

*"Then certain aspect is a lot of frustration, because I can't get anything done, and they're not growing.", P5*

P1 drew attention to tensions within their family in terms of balancing work commitments, supporting children's learning, and fun times:

*"I see mommy, but she is practically useless to me. Because she's in her work, and she cannot drop her meetings and come help over with my technical issues, or schoolwork issues... So I think they are getting more attached to daddy because he has energy and time.", P1*

Finally, the last major conflict at home is the increased cost associated with parents having to spend their own money upgrading internet and devices at home to accommodate for the increased throughput.

*"We had to upgrade our wi-fi as well. And the last category I would say is the software school software, it's not easy or intuitive to use.", P2*

## 4.6 Unusual Teacher Responsibilities

Similar to being defined in new roles, the teachers in our study also described having to take on some unusual responsibilities, which they did not necessarily feel well equipped to deal with. Some parents proposed putting their children in higher grades or even taking their children out of school altogether as possible solutions to issues noted by the teacher. This led to challenging conversations, where teachers felt the need to explain why that might not fix behavioral issues in and of itself. 3 of teachers described the challenges with dealing with families in non-nuclear units, such as when parents are divorced and not necessarily communicating well and/or having different rules in each house.

*"I have to not only educate children but also their parents about how to raise their kids and deal with their estranged partners. I am not trained for this.", P10*

## 4.7 Challenging Avenues of Communication

The final finding from our interviews reveals the ambivalent and/or contradictory ways that our participants described their reflections on the virtual learning experience. As the interview questions progressed from the general to the specific, there was a tendency for the participants to become more pointed in their criticism's of the parent/teacher/child dynamic. With the parents, they mostly initially expressed initial support for the activities of the teacher and their school district overall, but when discussing their own child's experience, this changed somewhat. While they acknowledged at first that they felt bad for the teacher's situation, in later stages of the interviews, the parents noted that they thought to teacher could do better.

*"Teachers are doing a great job... Teachers are not hearing our concerns and our children are suffering.", P2*

From the teacher's perspective, we noted a similar change over time in how the teachers in our study described their students. While initially highly supportive, they began to more sharply describe their opinions on the children's (mis)behavior over time.

*"Just spending time with students is great... Children's behavior can wear our patience thin more-so than when we interacted with them in person.", P3*

This contradiction could be explained in that the parents/teachers might not have had a chance to discuss this experience with an "outsider", so after developing some level of trust, the participants felt comfortable in more pointedly describing their feelings.

In reflecting on these conflicting perceptions, there may be opportunities for a virtual learning portal to address some of the issues. For example, the application could provide functionality for parents and children to give thanks to their teacher through the interface. This could be through emojis, stickers, or achievements, where the idea would be that either at the end of the day/week, students could give their teacher some positive virtual feedback through one of those techniques and acknowledge the work the teacher was doing. For the teacher, an automated transcript of what each individual child said during class could be shared with the parents (only their child's utterances). This could assist with difficult situations about poor behavior, where an accurate transcript could be a helpful conversation starting point. Other opportunities to consider include parent peer forum boards for discussion or the ability for parents to transparently "listen in" on a class by joining a lesson with the teacher's permission. I also studied this using Sentiment Analysis which shows that the interviewees have more negative emotion as the interview continues. This is expanded upon more in Appendix A.2.

## 4.8 Brief Follow-up Survey

A few weeks after I conducted the interviews, I followed up with this subset of parents, in addition to a broader set of parents, with a short survey form to find out their thoughts regarding plans for their children's education in the following teaching year. 38 parents completed the survey which asked "If you could hypothetically choose one of the following options for your child for the next school year, which one would it be given how YOU think this year's education went:". The three options for selection were: 1) Repeat kindergarten, 2) move on to first grade, or 3) remove from formal schooling if virtual (whether for repeating again or for taking first grade). The responses were 3, 32, and 3 respectively. This showed that regardless of the situation, the clear majority of parents did not want their child to repeat kindergarten.

Parents were either confident enough that their student learned enough through their virtual experience, did not want their child to fall behind for their age group, or they had enough confidence in virtual experiences that even if the first grade was virtual, they were confident enough in their child to move on. While three of the parents may have had concerns about their child's overall progress this year, it is also interesting to note that some parents favored having the child potentially at home, rather than have another year of virtual experiences.

# Chapter 5

## Final Prototype and Evaluation

### Interviews

Below are the features I considered based on data compiled from all of the interviews, in order to solve the issues that the critical stakeholders have. As stated in the previous section, technology is not always the solution to some of the hurdles that come with VE so these features attempt to solve the novel observations I noted and some of the obvious issues that arose. The purpose of the prototype is not to display the optimal design for these features but instead as a way to visualize how these features might operate. Each of the sections below will describe how the feature came to be and what hurdle it is trying to solve and how the teachers and parents reflected on the final prototype's feature.

These final set of interviews were conducted in early April 2021. These set of eight evaluation interviews were in the last stage in Figure 1.1. The interviews were not structured and focused on the stakeholders walking through the different features in the prototype and their static images shown in the figures below.

#### 5.1 Breakout Tables

The breakout tables are a feature that has been with the thesis from the beginning. The idea originated from how in the current system of breakout rooms, the moment a child is

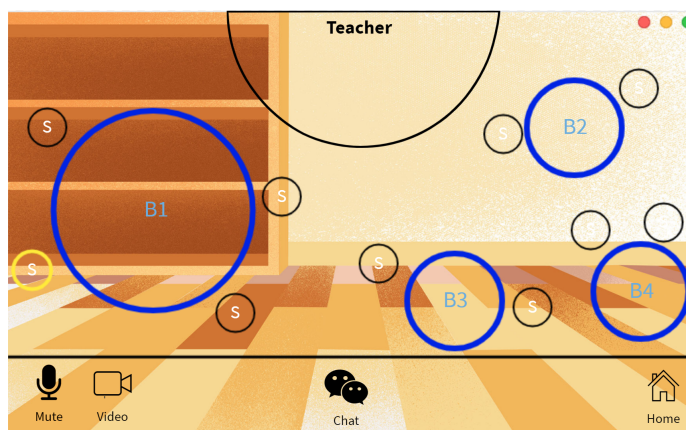


Figure 5.1: Final Breakout Rooms

put into a virtual room they lose sight of the rest of the class and become isolated. This causes the students in the room to lose connection with their classmates and does not foster a friendly environment – one that is necessary for kindergarten. This was also a problem for teachers as they felt they lacked control over the class as they could not monitor all of the students at once and going in and out of the rooms was too much of a hassle to quickly gauge how the class was doing. To mimic the in-person classroom this feature changes the way breakout rooms operate. First, the naming of the feature was changed to better reflect the activity. Instead of “rooms”, the nomenclature is modified to be “tables”.

This mimics how groups operate in the classroom. The next change is what happens when students are placed on a table. Prior they would lose sight of all of their classmates, but in this new format, students always maintain the view of their classmates. Instead of the UI placing in the different room, tables appear and the students’ video bubbles, relocate to their assigned table – picked by themselves or the teacher. The students would hear only the other students at their table but they would be able to still see everyone else in the classroom. This replicates how group tables operate when students are in person. If the students wanted to move between the tables all they would have to do, is to click on another table, but to maintain control, the teacher can limit the cooldown time and/or prevent

students from moving at all after their initial table selection/assignment. When evaluating this final design, parents and teachers appreciated the increased visibility that the students and teachers would have of the classroom. They feel that then the students are placed in the rooms, they can get emotionally frustrated if they feel they are not being listened to or observed. The new table layout would prevent that from happening and allow for the teacher to monitor all of the students with more ease. The teachers also appreciate the level of control that they have over the movement of the children as they would want to shift that level based on the activity the class is doing.

## 5.2 Regular Classroom View

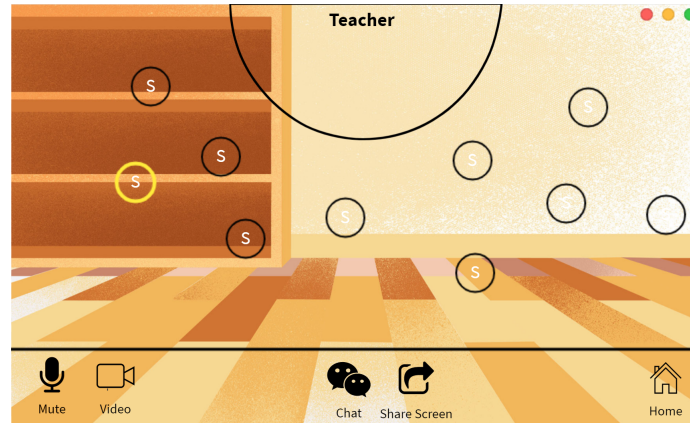


Figure 5.2: Final Regular Classroom

This feature is more of a redesign of how the default screen would look for the UI. Currently, the UI for the students is the rectangular view which is not the way that students see each other in the classroom. The block nature results in valuable screen space being taken up by unnecessary background and for fewer students' views to fit on a page. This new feature instead, would have the students' faces be represented by a video bubble and the UI would automatically be focused on the student's face and "crop" out the area behind the student.

The students' bubbles would also surround the teacher in a "campfire" position as this is what Kindergartners do when they are in person. As per the teacher's discretion, the students would be able to move their bubble around the screen to sit next to whoever they would like. If the teacher was teaching or sharing content on their screen, then the bubbles would not disappear but instead move to one side of the screen and the content would take up the other half and if necessary, the content could be made bigger but the students would always be able to see each other. This feature allows for the visibility of their classmates to always be possible, as in Kindergarten developing social skills is as important as education, and students cannot do that if they can not see each other. This feature attempts to solve that. Secondly, another issue this feature attempts to solve is the lack of privacy that VE causes. All critical stakeholders have expressed how having a video turned on throughout class invades the home privacy and that is not appreciated. By making the video screens, bubbles allow for the focus to be on the face while minimizing what goes on in the background relieving stress on both the families and the teachers.

When being evaluated by the parents and teachers, they like this new view and again found the increased visibility of seeing the entire class be beneficial. They thought that increased privacy also helps to maintain the focus of the students. Some of them expressed that the video bubbles themselves could be bigger and automatically scale to how many students are in the class, and that is a great suggestion so that the kids could see each other better. They also appreciate the new layout as they see the benefit of placing the teacher as the central focus in the classroom. Previously, there is no intuitive focal point in the classroom, but now with the teacher being in the upper center and the kids circling the teacher, it provides kids a natural place for them to look and be less distracted.

## 5.3 Free Time View

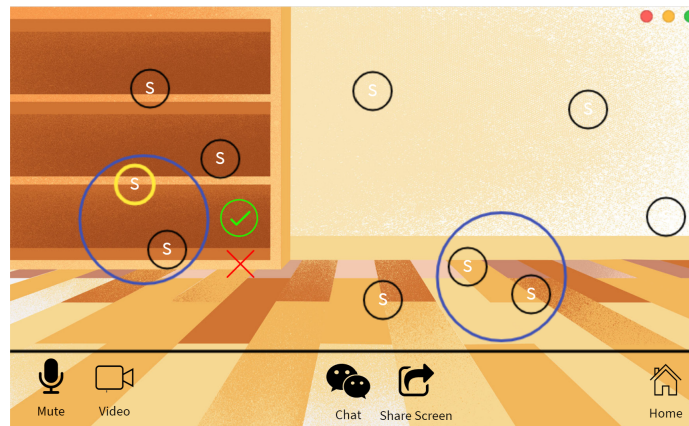


Figure 5.3: Final Free Time View

This feature emerged from a few different issues. The first is a problem that parents have on asynchronous days. The kids do not have anyone to talk to whether it be about questions they have on their work or just to talk to their peers so they end up questioning their parents a lot. While the parents enjoy helping their kids, they feel like they are becoming too much of a teacher on those days and want some of that responsibility to be relieved. Another issue is with teachers finding a better way to operate virtual recess which allows for the kids to pick who they want to talk to on their own, which is a key skill - necessary to developing independence. This feature operates in the following way. Students would freely be moving around on the screen. If they wanted to talk to a fellow student, they could click on that student and a “bubble” would appear around them indicating that they were in a group. Only at this time would they be able to hear each other but alike to the previous features, they would still be able to see the rest of the active students in the class. If another student wanted to join their group, then they could click on the group and an option would appear for the students already in the group to admit this student or not. Students can then choose to talk to their peers and the bubble would expand to include them if selected yes. Students can leave the group by selecting themselves.

When being evaluated, parents and teachers appreciated the freedom that students have in this new format as it would relieve the pressure on parents to “entertain” the students on asynchronous days and provide teachers a new way to have virtual recess. One concern that did arise was that of moderation and how activity from the students could be inappropriate would be treated. This can be addressed by having any free-time sessions automatically be recorded and saved in case any incident did occur. This footage could be used following the event to figure out the root of the cause and address the issue.

## 5.4 Teacher’s View

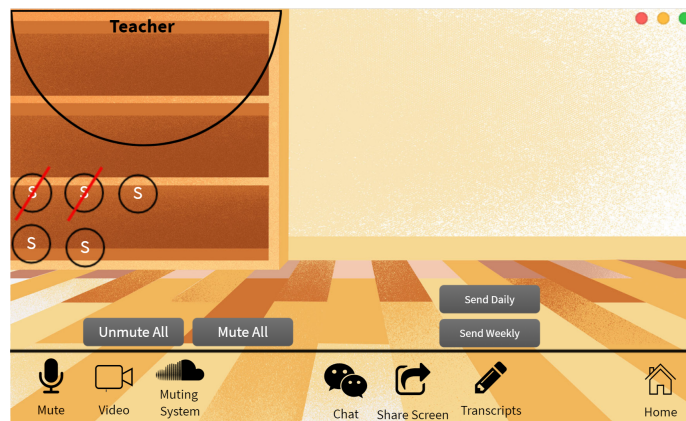


Figure 5.4: Final Teacher View

This view of the UI from the teachers’ perspective has two key features. The first is a new Muting System and the second is a Transcripts Delivery system. The Muting system came from a myriad of issues about how students and teachers interact online. When students are in person, talking over each other is different, there is no lag and students are more aware of when another person is talking to them. Secondly, teachers have more control when students are in-person through non-verbal cues to indicate when they want students to stop talking and the students are more responsive when they are in person. In an online

environment, teachers are limited in the control they have over the student's actions. Every critical stakeholder expressed concern over the muting system and wanted a more simplified way to control the students. When the teacher goes to their personal view, they would see a set of buttons to mute all of the students and unmute everyone. This is a feature that is lacking in the current system that is employed in the VE for Kindergartners. Secondly, if a teacher wanted to selectively mute a student, instead of having to open up a sidebar they would just have to click on the student and a red bar would appear over their screen indicating to the student, teacher, and the rest of the class that they are muted. To simply unmute the teacher would just have to click the student's image again. When having the feature being evaluated, teachers appreciated the feature because it decreased the number of steps that they had to take to mute a certain student and to simply mute everyone if there was a lot of chaos occurring all at once. Parents appreciate this feature as it provided their children with a clear way to visualize when they are muted. This visibility into when a student is muted is a key feature, as parents have expressed concern about situations when their child starts to cry because it believes no one is listening to them when the problem is that they are muted and no one is aware. Visibility is a common theme in Kindergartners as generally their tolerance for conflict is significantly lower than in higher grades.

The second feature in the teacher's view is a transcripts feature. Parents felt as if they did not think their teacher was doing an effective job and thought that their child was not participating enough during the day resulting in tension between the teacher and the parents. Also, teachers felt as if they were describing what they were doing in class multiple times to parents. To alleviate these tensions, the transcripts feature is a way to give parents a clear indication of what goes on in class by giving them a word-by-word walkthrough of what happened during the school day and who said what. The transcript would highlight when their child talked and this would give parents the information to identify how much their

child interacts with other students as well as provide them insight into the difficulty that teachers face in controlling 20-30 students online. Teachers can also control if they want this transcript to be sent at the end of the day or the end of the week so that parent's inboxes do not get overfilled with emails. When being evaluated, teachers thought this was a nice feature and appreciated that parents would now be able to have a better view of what occurs in the classroom. A suggestion they had was to include an option to selectively send who got the transcript so that instead of sending it to all of the parents, only whoever they chose to send it to would receive it. The parents liked the feature and mentioned how it would give them the option to read it on their own time instead of attending class themselves or during parent-teacher conferences.

The teacher's view, represented above, is similar to the student's view. One of the reasons why this view is similar to the student view is so the teacher can assist and understand the position the students are in if any technical difficulties occur on the students' end. Originally there was some thought about creating a separate teacher view and UI but those thoughts were put aside after conversations with teachers. Teachers with the new online system are having to deal with significantly increased workloads and having to work in a different view from students would require additional hurdles for the teacher to deal with. The more different the views are the more technical challenges might occur and the goal is for the UI to be simple and understandable for everyone involved. Teachers are already having difficulty when trying to incorporate 3rd party tools into the UI, which the student can not interact with, therefore adding a radically different view for teachers would only exacerbate this issue.

When trying to tackle the problem of parents feeling left out of the loop and incorporating their needs into the UI there was some intuition about creating a separate parents' view, however, this motivation behind creating this fell apart quickly after the semi-structured

interviews. Parents are already dealing with increased stress because of the technological hurdles of having to log in and make sure their children have all of the necessary tools on their computers. Parents want a more simplified version and interface to monitor and deal with their child's education. Adding on an additional parent view would only complicate the system. Instead, I propose for an additional messaging app/forum board to be created where the parents can talk to each other and post questions for the teacher. This way they can better see their questions addressed by the teacher, instead of feeling like their questions are being buried in the teacher's email inbox. Secondly, parents expressed that in the new child's views that it would be sufficient to see what is going on in class along with the additional Agenda and Transcripts features.

## 5.5 Bathroom Button



Figure 5.5: Final Bathroom Button

This feature may seem trivial and not necessary but the background for this feature emerged from significant issues that occurred between the students and the teachers. During the online class, a teacher has to be aware of where a Kindergartener is at all times as they are not just a teacher but also like a 3rd parent. The students also treat teachers like a 3rd

parent so whenever they have to use the bathroom, they raise their hand or interrupt the class asking the teacher if they can go to the bathroom. This not only disrupts the flow of class but also results in other students becoming distracted which causes the teacher to lose time trying to get everyone back on track. Instead, when the student presses the button their video and audio turn off and the teacher quietly gets notified that the student left to use the restroom. This way the teacher is notified when the student leaves without disrupting the flow of the class. When evaluated, teachers appreciated the feature as it would greatly help them operate the flow of the class. Parents also appreciated that the video turned off automatically when the student walked away because it gave the families more privacy in their own home.

## 5.6 Virtual Manipulatives

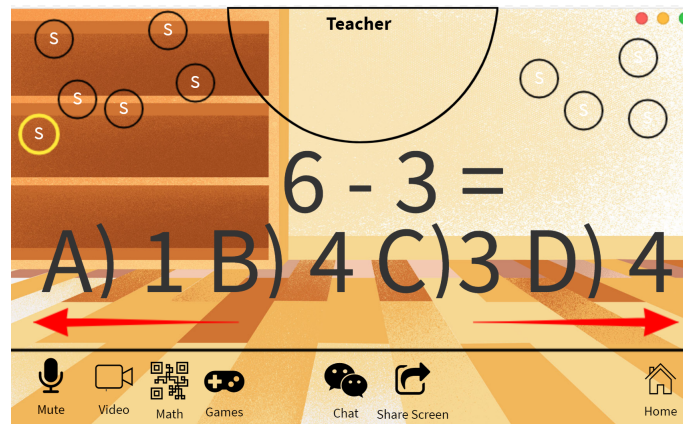


Figure 5.6: Final Virtual Manipulatives

Virtual Manipulatives were suggested as a new feature for a UI unanimously by all of the teachers throughout the interview process. With VE current technology, teachers are highly limited with the tools that they have to educate students. They either rely on drawing their math or English lessons on their computer and sharing their screen or on 3rd party

tools such as Google classroom. Having virtual manipulatives be built into the system can allow for teachers to save time and allow for the kids to be more engaged in what they are learning. The first virtual manipulative is to focus on math. Generally, teachers have to do polls in a chat where the text is incredibly small. In this new feature, the math itself takes center stage and offers a multiple-choice question as to the primary view for the students. The students can click on their answer and move on to the next question when they would like or at the discretion of the teacher. The second manipulative is a game, which is called Draw-man or more commonly known as Hangman. The reason for the change in the name is while it may seem innocent to those of us who grew up playing Hangman, the actual terminology is not appropriate for children which is why the name has been modified for children. The manipulative would work, by the students calling out their guesses in order, and the teacher would be the one controlling the operation of the game. The key factor here that is different than just drawing on an empty screen is that the system is built into the UI so it saves time for everyone involved and is more engaging to the students. When these were evaluated by parents, they appreciated that new content as engaging the children in the education is a large struggle when the students are young. The teachers also appreciated the built-in games and manipulatives as it saved them time and expressed that they would like more manipulatives beyond multiple-choice and a variety of games to be developed so they can have more flexibility in the work that they do. It is critical to emphasize here that the views shown in the prototype are just meant to visualize the novel ideas that have come from the interviews and analysis and do not necessarily provide the optimal design as that is not the goal of this thesis.

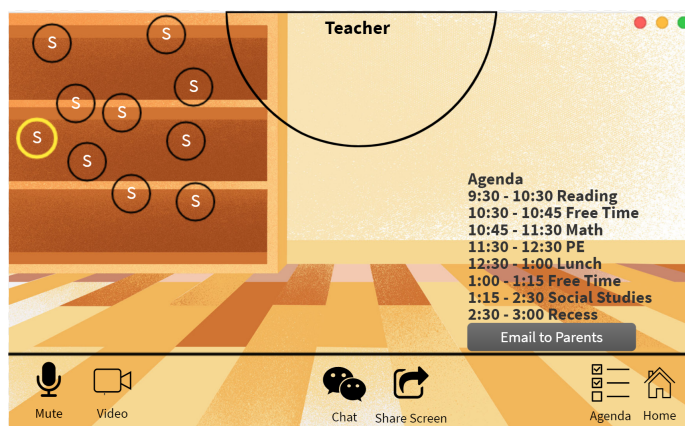


Figure 5.7: Final Agenda View

## 5.7 Agenda

This feature came from the same issues that resulted in the Transcripts feature being added. There is a tense relationship between parents and teachers and to alleviate some of these concerns increased visibility into the child's education is necessary. The Agenda feature tackles this problem by having a button on the screen that the child or their parent can press that can show them what lesson the child is currently on and what they have/will do for the rest of the day. By adding this view in, it can show parents what their child is doing every day. When evaluated, parents thought it was helpful because, children do not always provide accurate descriptions of what they are doing, so having a view that the parent can just come over and see their agenda is helpful. Teachers appreciate the feature because now they do not have to tell the parents what they did the entire day multiple times, and helps them explain what is going on in their child's classroom.

# Chapter 6

## Discussion and Future Work

After going through multiple rounds of interviews, focus groups, and design cycles I have found novel observations into how teachers, parents, and children in Kindergartners interact with each other and how a VE can be better developed to meet their needs. Starting with the literature review, it is clear that VE can help students learn even if they are not placed in difficult environments. Researchers have avoided researching children in virtual situations because they either believe not enough reliable data can be drawn from studying them or the only solution is to send them back to school and virtual education can not be a solution for young children. The problem with that mentality is it only causes the gap in research involving children to only grow larger. During the pilot study, some of these issues became clear as it started to become evident that my intuitions of how mainstream VE tools are not one-size-fits-all and meeting tools built for Fortune 500 companies are not designed to help Kindergartners learn. Another issue that began to emerge is that while the level of education has slightly decreased, social development has taken a much larger hit. This was not only noticed by teachers and parents but also by Graduate Students who themselves have been dealing with learning in the pandemic. When initial solutions were discussed in the interviews and focus groups many of the key stakeholders indicated using 3rd party tools to solve these problems. This is clear evidence to me that if the people interacting with the system themselves do not trust that the tool can provide enough resources for the students to learn effectively, the education will be affected. Based on these primary results, three

prototype ideas began to emerge: Breakout Rooms, New Default Classroom View, and a Free Time View. These had positive feedbacks when evaluated but during the second set of interviews, the feedback was more technical in how to improve the VE system. Some of the themes that emerged were to create a more Child-Friendly design and to make the UI easier to interact with while giving the teacher an increased level of control. Social issues were still emergent as two of the themes focused on increasing the interaction that students had with each other and involving parents.

All of these conclusions permeated throughout the third set of semi-structured interviews yet these focused more on the social issues that were occurring in the classroom. Observations seen in the initial focus group were apparent as parents expressed how their children were not receiving enough attention nor talking to their classmates. Teachers expressed increased levels of tension. It was interesting to me that even from individuals who were not younger children – the Graduate Students Focus Group – face similar issues. This indicates that work in this thesis does not only benefit Kindergartners but students in all grade levels. While some of the levels of control and design decisions might be more directed towards helping children, the social issues that were seen and addressed can benefit children in all grades. Features like the bathroom button have expressed interest from parents wanting to have a similar feature in their work meetings. The automated tracking system has peaked interest from all grade level teachers as it can better identify students who are not participating allowing for the teacher to focus more on teaching rather than tracking who talks during class. The ideas found in this paper have larger applications than just in improving the education in Kindergarten. Just because the pandemic is coming to a close does not mean this issue can be dismissed. The pandemic has forever changed the way that we interact with each other and the recommendations and observations found in this thesis can help bridge the gap between the nature of more work being done virtually. This paper is

only the start of helping close the gap in research that exists in how children are specifically affected because of VE. I have realized that society has addressed this problem by putting a blanket statement that young children should just have to go learn in person as VE cannot replicate the in-person learning because the tools are not developed to meet their needs. I believe that this paper is the beginning of those tools becoming better tailored to the needs of their users.

# Chapter 7

## Conclusion

This thesis was heavily shaped by the Covid-19 Pandemic, both in its timeline and in the research itself. This entire thesis was conducted online from the research meetings to all of the focus groups and interviews. Over the nine months, there have been multiple design cycles, interviews, and the project has shifted based on the needs of the stakeholders and the capability of myself for conducting this research remotely due to the pandemic. Conducting these over a virtual environment has definitely been a struggle and helped me to understand the position that teachers are in as they not only have to overhaul their entire curriculum for online teaching but also deal with onboarding all of their students. I designed new user interfaces and features to better help Kindergartners learn through the lens of Virtual Education. I evaluated the results of my research through Open Coding and Sentiment Analysis to identify key themes. I successfully interviewed key stakeholders and held focus groups to evaluate those designs to develop a series of recommendations and novel observations which to reflect the needs of the users. The research shows a promising future for Virtual Education for Kindergartners if enough funding is put into developing the conclusions found in this thesis on a larger scale. I am excited to see the future research and products that are developed in this field and hope that my research helps to fill the gap in knowledge about how Virtual Education can be better implemented in K-12 education.

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# Appendices

# Appendix A

## Appendix

### A.1 Semi-Structured Interview Questions

#### Teachers

**Demographics:** Age, Teaching Background, Taught Virtually Before,

1. What does a usual school day look like for you in this era of COVID-19? How has your schedule changed?
2. How do you structure the class to teach the students? How does the plan vary day to day?
3. What is your primary tool to communicate with the students? Is all of the teaching done synchronously or asynchronously?
4. How do you maintain the focus of all of the students throughout the class?
5. What are your strategies for mimicking in person teaching tools to an online environment?
6. What does your relationship look like between yourself and the children that you teach? What about their parents? How has this relationship changed from your time teaching in person?
7. What challenges do you encounter when teaching students virtually and how do you

overcome them?

8. What is your satisfaction level with your experience teaching this semester? Is that very different from your previous experience?

### **Parents**

**Demographics:** Age, People living at home, Work Background, Work from home before,

1. What does a usual school day look like for you in this era of COVID-19? How do you start the morning and deal with having children learning from home?

2. How do you balance your work and life activities now? If you have more than one child, how do you manage siblings?

3. How do you prepare your schedule for teaching your child from home?

4. Has your relationship with your child changed since learning at home began?

5. How has your relationship with your child's teachers changed, if at all?

6. What challenges have you encountered with having your children home with you for an extended period?

7. What are your thoughts on the teachers approach to virtual education? Do you have any recommendations for things you might like to change?

Additional Questions for both

Based on the conversation, additional questions may be asked.

## A.2 Sentiment Analysis

When analyzing the transcripts of the data through Open Coding, the novel observation of the internal conflicts made me want to analyze the sentiment of the parents and teachers throughout the interview. Many times, the parents and teachers would contradict themselves when discussing their answers and thoughts about their children. It made me wonder if the person being interviewed became more emotional throughout the interview and if so, was it positive or negative. The two python libraries that I used to do my analysis were Nltk and Text blob. The reason why I used these two libraries was that they are the most commonly used libraries when it comes to Sentiment Analysis. Secondly, both of the libraries are trained on different test sets. Nltk is trained on tweets so it is better at identifying sentiment in short sentences and slang words. Text Blob has been trained on longer sentences and passages so it is better for formal language texts. I thought studying the transcripts through both of these libraries would prove to give information about the sentiment in the languages. For both libraries, I split all of the transcript texts into two sections, the first half and the second, and used those as the data to detect if there was more emotion toward the latter half of the interview. I began with Nltk and when detecting if there was an increase in language that was emotion-based, there was a 4.9 percent increase in general emotion. There was, however, a 9.6 percent decrease in positive emotion and a 7.7 percent increase in negative emotion throughout the interview. When evaluating the same data through Text Blob there was a 32.9 percent increase in emotion throughout the interview. These increases in emotion show that as a parent or teacher becomes more comfortable with the interviewer, they are more willing to talk about how they feel about the situation and fewer answers about what they think I want to hear. Also, this data shows that parents and teachers do have their feelings bottled up, and this is probably the first time they have been able to talk about the situation with a 3rd party, so allowing them to open up as shown by the increase in emotion

is almost therapeutic and can indicate how stressful this situation has been for all of the involved stakeholders.

### **A.3 Accepted EDUlearn21 Paper**

#### UNDERSTANDING THE EFFECTS OF VIRTUAL EDUCATION ON YOUNG CHILDREN AND THE RELATIONSHIPS BETWEEN TEACHERS, PARENTS, AND CHILDREN DURING A GLOBAL PANDEMIC

The global COVID 19 pandemic dramatically altered the early education teaching landscape worldwide. The switch to a virtual education model left many educators, parents, and students scrambling to access appropriate technologies, adjust complex schedules, and attempt to learn in a radically different way. For very young kindergarten-age children, their introduction to formal education via virtual technologies in 2020/2021 has been particularly challenging. To understand more about the inter-related experiences of children, teachers, and parents engaged in kindergarten learning during this challenging time, we conducted a series of online in-depth interviews with the key stakeholders in this endeavor. The goal of our study was to determine how parents and children coped with a virtual education model, how teachers adapted or abandoned teaching practices, and how future virtual learning technologies might best support students, parents, and their teachers in achieving their goals. Our findings describe communication issues, the new (and not always welcome) roles for both teachers and parents as coaches, therapists, and teacher-parent, and emotional familial conflicts about learning and working together during lockdown. We propose four interactive virtual learning interfaces to address some of the issues uncovered and examine their potential implications with invested stakeholders.

Keywords: Covid-19, Kindergartners, Parents, Teachers, Relationships, User Interface.

## INTRODUCTION

For kindergarteners, one of the key objectives of their experience is to encourage the development of relationships and communication between peers, as well as recognize the authority of another adult beyond their parent(s) or primary caregiver. This entails not only talking with their peers but cultivating meaningful relationships and actively participating in the classroom [1]. Learning experts have long drawn attention to the power of learning *by doing* ([2], [3]), and especially *collaboratively* in social environments [4]. For children of kindergarten age, moving between individual exploration and collaborative engagement is best when encountered in multiple contexts, including in pairs, small cohorts, in the classroom, and at home [5]. Other goals include the students being able to recognize one another's emotions, express concern in times of stress and assist their classmates indicating a sense of connection [6]. In school, kindergarteners have to understand how to cultivate these relationships on their own and initiate this behavior [1]. Being able to develop these skills is critical as this is when children first learn how to interact with other children who are not their family and began to learn the challenge of prioritizing "others" over "themselves" .

The COVID-19 pandemic has dramatically altered the ways that humans work, learn, distract, and entertain themselves [7]. While the shift in routine towards online interactions is certainly challenging for adults, it also produces additional difficulties for less familiar technology users, including the elderly and young children [8]. Virtual education for university students has been reasonably well explored, particularly in countries with students spread over large distances in geographically complicated environments ([9], [10]). However, this past year, for many children of kindergarten age, their first introduction to semi-formal learning involved navigating video conferencing software that was not designed with this particular consumer in mind [11]. For parents trying to work from home under already challenging conditions, the need to provide technical support for young children in addition to their other responsibilities had the propensity to greatly increase levels of familial stress. Tools such as Zoom or Microsoft Teams are designed for users who can read, recognize the meanings of icons, understand functionality hierarchies (i.e. dropdown menus), and have rudimentary problem solving skills when things go wrong.

To understand more about the challenges for children, parents, and teachers in supporting kindergarten teaching and learning through screen interfaces, we conducted an online interview study with six parents of

kindergarten children and four kindergarten teachers, all located in Virginia, USA. As part of the study, we also demonstrated interactive application to the participants that depicted alternative kindergarten virtual learning experiences. Our findings point to issues with the new roles required of parents and teachers alike in this novel distant situation, conflicting relationship dynamics that emerged over the course of lockdown, and some emotional familial problems that surfaced as a result of competing schedules in the combined home work/learning space.

## METHODOLOGY

We used a three-stage iterative design process as depicted in Figure 1 to accomplish the following: 1) understand some of the current effects of virtual education on young children and the changing relationships between teachers, parents, and children; 2) create a digital prototype of a more child-oriented virtual learning interface; and 3) develop a set of general design recommendations for virtual education tools for very young children. We used a variety of qualitative and quantitative methods in this work including interviews, prototyping, and data analysis [12].

We conducted semi-structured interviews with six parents of kindergarten students and four kindergarten teachers. The interview study protocol was approved by the Institutional Review Board at Virginia Tech. The eligibility requirements for the study were as follows: 1) parent of a child aged between 4 – 6 years old who had received virtual school instruction OR kindergarten teacher who had delivered virtual school instruction 2) be between 18 - 85 years of age; and 3) be proficient in written and spoken English. We identified and recruited subjects by snowball/word of mouth over email. Subjects were recruited from the Fairfax school district in Virginia. Figure 2. presents the demographic information of the study participants.

During the interview, participants were asked a series of questions in a semi-structured interview format. Topics covered included determining morning routines pre-school, work/life balance, relationships between

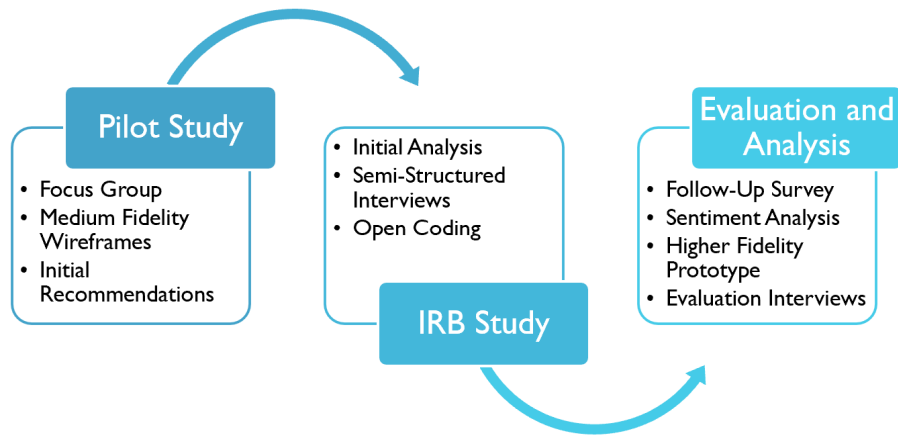


Figure A.1: . Stages of research

PID	Role	Age	Children in Kindergarten	Interview Duration	Job
P1	Parent	48	2	30:18 min	Business Consultant
P2	Parent	44	1	43:33 min	Microsoft Developer
P3	Parent	44	2	28:02 min	Photographer
P4	Parent	42	1	34:04 min	Stay at Home
P5	Parent	37	1	29:19 min	2nd Grade Teacher
P6	Parent	34	1	26:16 min	High School Teacher
P7	Teacher	51	1	44:40 min	Kindergarten
P8	Teacher	44	0	28:50 min	Kindergarten
P9	Teacher	45	0	16:06 min	Kindergarten
P10	Teacher	48	0	42:10 min	Kindergarten

Figure A.2: . Study participant demographics

families and teachers, and overall challenges encountered with learning experiences during this difficult time. We also showed the participants medium fidelity wireframes that we created after an initial informal focus group session with parents, teachers, and graduate students at our home institution. The interviews were conducted over Zoom, recorded with permission, and then automatically transcribed. We analysed the transcripts using a process of open coding, working together in labelling two of the transcripts [13]. Following discussions, we developed a list of codes that were used to label the remainder of the transcripts [14]. The research team worked together to categorize the codes into primary themes. The six primary identified themes are presented in Figure 3.

## Study Results

### Negative effects on student learning experience

The parents in our study reported two primary issues with their kindergarten children's experience with online learning. The first concern was that expressed misgivings about how other student's actions in the virtual classroom were negatively affecting their own child's education and how interactions with their teachers involved some levels of misunderstanding. A common concern from parents about other students was that they were talking over their child and they believed that their child's voice was not being heard. Teachers noted issues with trying to selectively mute students, so to keep things under control, they tended to mute everyone. This sometimes had a negative effect as noted by P2: "*Kindergarteners sometimes will cry off the camera, because there is no way like if the teachers accidentally mute the mics*", P2. From a different visual perspective, P4 also noted her child's frustration for example: "*My kindergartener will hold up her work, but nobody sees her. And she, in the beginning, didn't realize that no one could see her. And she kept waiting and waiting for someone to say something. But I mean, the teachers have no idea.*"

A second concern noted and remarked on by parents and teachers alike related to the amount of assistance/help offered by parents who were now sitting alongside or near their children in the home. The

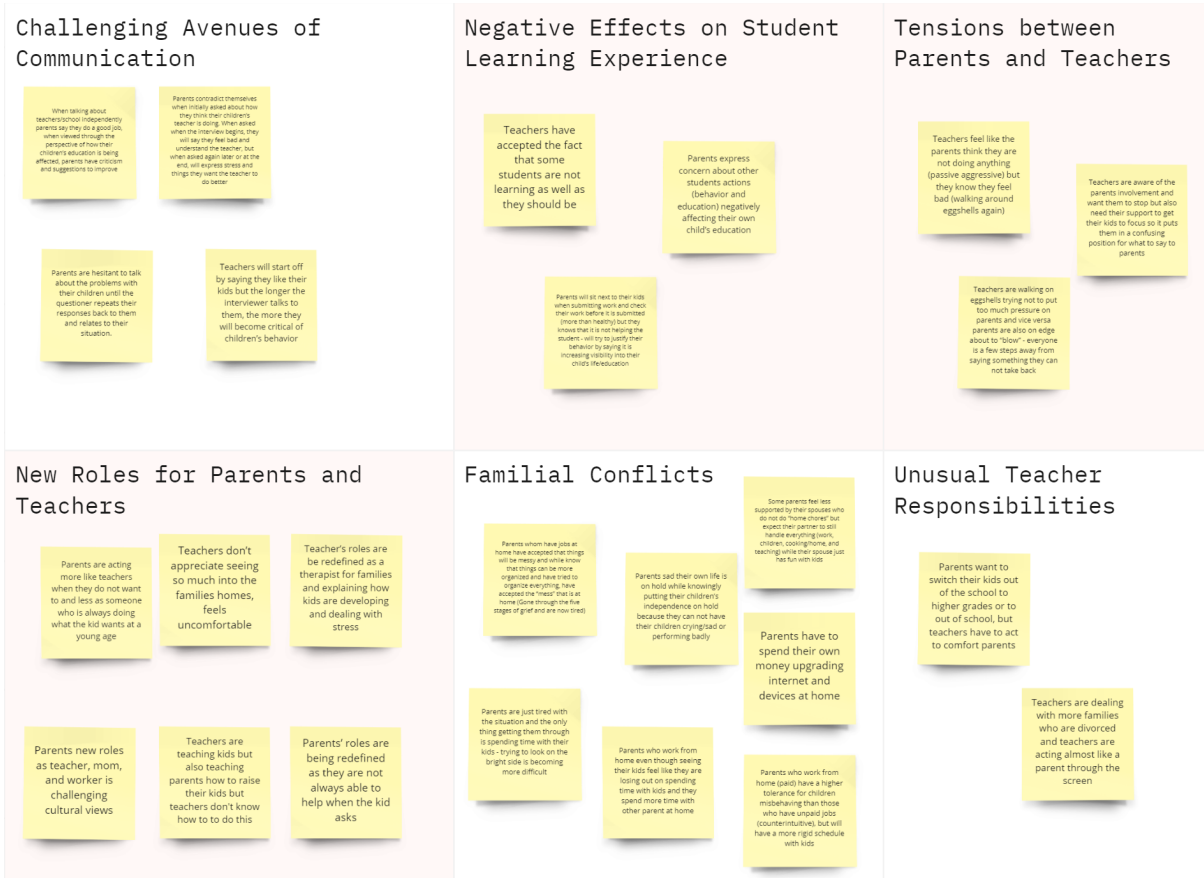


Figure A.3: . Six primary themes and clustered examples

parents justified their desire to assist their children (and to be seen as assisting), as noted by P4: *“But just to double-check that they’re submitting it right, they sometimes have trouble. So because I double-check before submitting [increases my] visibility.”* Parents noted that because they could now effectively listen in on activities in school, they were more aware of their child’s experience. Parents displayed varying reactions to this, ranging from frustration at hybrid communication modalities, to feeling overwhelmed by the amount of parent/teacher communication. For example, with the former, P5 stated: *“Sure she’s swamped. But I mean, some of those questions don’t always get answered. So I feel like it gets missed. And then you know, she might send out a, he might address it in another form, like a few days later, it’s not to me.”* Another parent expressed interest in getting summary details about their child’s daily experience: *“Just a summary. So I didn’t have to worry about going through, you know, 20, or however many emails.”*

## New Roles for Parents and Teachers

It became apparent during our interviews that parents and teachers are being forced into new roles that they do not necessarily have the training for or do not know how to complete, resulting in stress. The first is that parents are being forced into the role of being a teacher. This is in large part due to asynchronous days in which teachers just give work for students to do at home without having class. *“I’m like almost prepared, like, okay, Mondays, I gotta like watch over them. So yeah, it’s certainly a source of stress.”* Parents on these days have to push their children to do work, but because the direction is coming from their parents, children rebel more owing to the parent/child dynamic. *“If the teacher asked her to do something she didn’t want to do, she would just do it. But because I’m her mom, you get more pushback.”* On days when there is synchronous learning, parents have to stop what they are doing to assist the teacher in getting their child to focus and pay attention if their child does not want to, which takes time away from their own lives, blurring the lines between school and home. *“And we can only prep them so much all the time. I mean, there are days where we’re busy, and they don’t, they don’t always have they have everything.”*

From the teachers perspective, several noted that they were acting more like therapists for parents and less as teachers for their children. Teachers expressed frustration about having to have long virtual conversations with parents about how they should be raising their children, which they felt was placing a burden on them to direct the parents on how they should act with their children, particularly with regards to teaching certain

assignments on asynchronous days. *"The mom can't be sitting next to her for the rest of her life, holding her hand making sure to pay attention in class. Right? Like she's got to develop those skills on her own."*

## Tensions between Parents and Teachers

During the interviews, the teachers described growing tensions with parents over the course of the pandemic. The believed that some of the parents gave the impression that they thought the teachers weren't doing enough, but weren't coming out directly and saying that. P7 described how they thought there were misunderstandings between parents and teachers because: *"And people [Parents] like can misread your tone and stuff like that."* While acknowledging the stresses everyone was going through, the teachers described the tensions between trying to support the children with independent learning, but also helping the parents to support their children. This issues was noted by P10 who stated: *"So some of the work isn't as authentic on their own, because the parents are like, spelling everything for them, or they're just not independent."* Several of the parents acknowledged this directly, with P4 saying: *"I double-check all their work."*

In response, the virtual education platform could be improved by making accounts for parents and incorporating them into the classroom environment. Every week, if the parent chooses to, one parent could lead a book reading or a virtual activity in their online module for the class. The purpose of this would be to show the amount of work that goes into handling 20 to 30 students virtually. This would be different than the teacher just describing the work because many times parents might not understand until they experience the pressures that teachers experience. Another tool that the prototype could have is to generate a transcript of the class and at the end of the day it would get sent to the parents so they would have a direct and more convenient report of what happened in class. This would also support the teachers in their efforts to explain to parents what they are doing every day and why their increased 1:1 conversation with their children might not be as easy as it seems.

## Familial Conflicts

The interviews surfaced several interpersonal family conflict situations that may be beyond the abilities for a technology to solve. Parents who were working full-time outside of the house before the pandemic seemed more accepting about the fact that things would get messy with everyone being at home and that organizing efforts might not always work out. They also described a higher level of tolerance with regards to children 'acting out' at home, as opposed to parents who worked in or from the home prior to lockdown. Issues of productivity and/or unfair distribution of workloads were also described. P5 described how everyone was really losing out as: *"Then certain aspect is a lot of frustration, because I can't get anything done, and they're not growing."* P1 drew attention to tensions within their family in terms of balancing work commitments, supporting children's learning, and fun times: *"I see mommy, but she is practically useless to me. Because she's in her work, and she cannot drop her meetings and come help over with my technical issues, or schoolwork issues. . . So I think they are getting more attached to daddy because he has energy and time."* Finally, the last major conflict at home is the increased cost associated with parents having to spend their own money upgrading internet and devices at home to accommodate for the increased throughput. *"We had to upgrade our wi-fi as well. And the last category I would say is the software school software, it's not easy or intuitive to use."*

## Unusual Teacher Responsibilities

Similar to being defined in new roles, the teachers in our study also described having to take on some unusual responsibilities, which they did not necessarily feel well equipped to deal with. Some parents proposed putting their children in higher grades or even taking their children out of school altogether as possible solutions to issues noted by the teacher. This led to challenging conversations, where teachers felt the need to explain why that might not fix behavioral issues in and of itself. 3 of teachers described the challenges with dealing with families in non-nuclear units, such as when parents are divorced and not necessarily communicating well and/or having different rules in each house. *"I have to not only educate children but also their parents about how to raise their kids and deal with their estranged partners. I am not trained for this."*

## Challenging Avenues of Communication

The final finding from our interviews reveals the ambivalent and/or contradictory ways that our participants described their reflections on the virtual learning experience. As the interview questions progressed from the general to the specific, there was a tendency for the participants to become more pointed in their criticisms of the parent/teacher/child dynamic. With the parents, they mostly initially expressed initial support for the activities of the teacher and their school district overall, but when discussing their own child's experience, this changed somewhat. While they acknowledged at first that they felt bad for the teacher's situation, in later stages of the interviews, the parents noted that they thought to teacher could do better: Early in interview: *"Teachers are doing a great job"* ; Later in interview: *"Teachers are not hearing our concerns and our children are suffering,"* (P2).

From the teacher's perspective, we noted a similar change over time in how the teachers in our study described their students. While initially highly supportive, they began to more sharply describe their opinions on the children's (mis)behavior over time, starting from *"Just spending time with students is great"* , to later stating – *"children's behavior can wear our patience thin more-so than when we interacted with them in person"*, (P3). This contradiction could be explained in that the parents/teachers might not have had a chance to discuss this experience with an "outsider", so after developing some level of trust, the participants felt comfortable in more pointedly describing their feelings.

## Virtual learning prototype

In response to the interviews, we developed four interactive interface prototypes depicting potential solutions to the problems encountered by the teachers, children, and parents in our study. We recognize that several of the emergent themes cannot be solved by a technological intervention alone, but rather require thoughtful and constructive discussion and/or compromise. We presented the four virtual learning interfaces as interactive walkthroughs to eight participants to gather their impressions.

## Rethinking breakout rooms

Teachers and parents acknowledged that there were issues using tools such as Zoom in controlling and monitoring children, particularly in breakout rooms when the teacher could not always be present. These rooms also created stressors on the children in that they would sometimes get frustrated if they felt that they weren't receiving enough attention from either their peers and/or the teacher. This lack of visibility directly relates to the issues described in 3.1 about negative effects on children's learning. In response, we propose a revised interface as depicted in Figure 4, which visually more closely resembles a classroom environment. Here, instead of separate rooms, we use the metaphor of tables, where the students (represented as small circles) can be assigned. The students would hear only the other students at their table but they would be able to still see everyone else in the classroom. If the students wanted to move between the tables they could possibly click on another table, but to maintain control, the teacher could choose to allow or prevent students from moving after their initial table selection/assignment.

When evaluating this final design, parents and teachers appreciated the increased visibility that the students and teachers would have of the classroom and felt that it would increase their sense of being listened to and observed. The teachers also appreciated the level of control that they could have over the movement of the children as they would want to shift that level based on the activity the class might be engaged in.

## Free time view

The parents in our interviews described the stay-home asynchronous days as being particularly challenging, when they were charged with supervising the completion of small projects and tasks in the absence of the teacher. The tensions revealed between teachers and parents (in sections 3.1 and 3.2) around "helicopter" supervision by parents also prompted us to consider overt opportunities for children to learn and socialize independently. To decrease the burden on parents and to enable children to have an opportunity to demonstrate independence, confidence, and responsibility, we propose a "free time" interface as depicted in Figure 5.

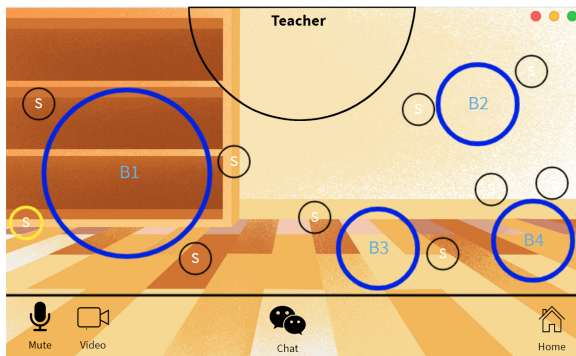


Figure A.4: . Breakout room video, with four tables

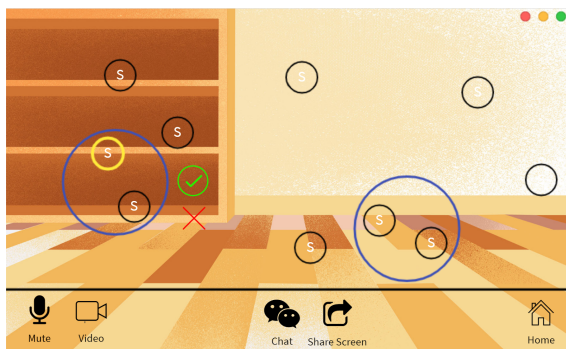


Figure A.5: . Breakout room video, with four tables

In this interface, students could independently move their “circles” around the screen. If they wanted to talk to a fellow student, they could click on that student and a navy “bubble” would appear around them indicating that they were in a group. During this time, they would be able to hear one another, while also being able to see the rest of the active students in the class. If another student wanted to join their bubble, then they could click on the group and an option would appear for the students already in the group to admit this student or not. Students could then choose to expand their conversation bubble. Students could also leave the bubble at any time. The parents who viewed this interface appreciated the freedom that students might have in this new format as it would relieve the pressure on parents to “entertain” the students on asynchronous days and would also provide teachers with a new way to have virtual recess. However, both teachers and parents expressed concerns about moderation and as a compromise, suggested that free time sessions should be knowingly recorded in case of any unpleasant incidents.

## Teacher view

The teachers in our study described their frustration at the difficulty navigating the muting and unmuting features in Zoom, and the confusion this also caused with students who didn’t understand why no-one was listening to or engaging them. We proposed an alternate interface, depicted in Figure 6 which would give the teacher easier access to the muting functionality and increase the visibility of the feature for the students. Teachers would have the option of muting everyone, unmuting everyone or selecting individual students or tables of students to mute and unmute. The functionality would be accessed by simply selecting a student ‘circle’ to mute them, resulting in a red bar appearing over their circle letting everyone see who had or had not permission to talk.

The teachers described their appreciation for the feature because it decreased the number of steps that they typically had to take to mute either everyone or particular students during noisy classroom times. Parents also felt that it would provide their children with a clearer and more visible way for them to understand whose turn it was to talk in the classroom.

## Bathroom break

Several of the teachers in our study noted that when children at home needed to use the bathroom, they tended to interrupt the class to request this, which could be disruptive. In response, we proposed the introduction of a simple bathroom button which the student could select, thus turning off their video and audio while also sending a notification to the teacher about their status. This way the teacher is notified when the student leaves without disrupting the flow of the class. The teachers in our study appreciated this proposed feature as it would greatly help them control flow of the class. Parents also appreciated that the video turned off automatically when the student walked away, because it could increase the family's sense of privacy in their own home.

## Conclusion

The findings from our work surface challenges and opportunities for improving the experiences of young children, parents, and teachers engaged in virtual kindergarten education. While some of the complex relationship dynamics discussed (between parents, and some between parents and teachers) clearly require interpersonal communications and activities to resolve, we believe that even minor technological adjustments of virtual learning environments could help reduce incidental stressors that can contribute to broader tensions. Deeper consideration of the learning requirements of young children (both in and outside the classroom) could help software developers refine their one-size-fits-all approach to audiovisual communication between consumers of varying abilities, ages, and contexts. Simplifying functionalities, using familiar visual metaphors, and supporting the developing individual and social needs of early learners could better support young children in virtual learning contexts. These approaches further could also generalize into other learning areas, serving to create a more sustainable approach for all distant learners, temporarily incapacitated students, and those impacted by catastrophic weather events.

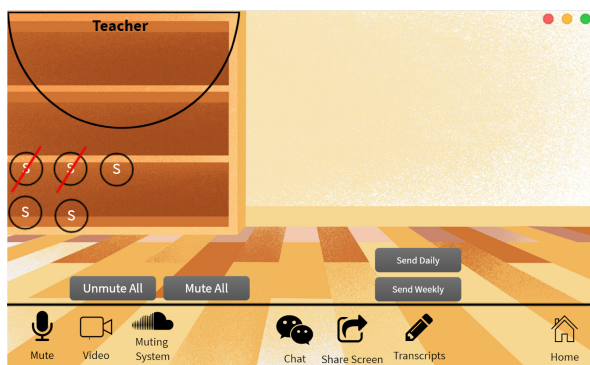


Figure A.6: . Teacher muting view