ABSTRACT
Documentation of development is a critical aspect of the work of early childhood education teachers. Through field observations and interviews, we detail the process and tools used in documenting development for children age three months to five-years-old at one school. Teachers use paper forms and printed photos to record and analyze observations of development. The evolving final product is a paper portfolio of development. This practice relies heavily on the teacher’s ability to objectively observe children in situ, create a record of the activity, and make salient the link between evidence and developmental milestones. We describe current paper and photo documentation practices in light of an online record keeping system that will be introduced at this school within the next year. The present analysis contributes to a growing literature on the role of paper and digital media in documentation.

Author Keywords
Documentation; Education; Paper; Photos; Preschool

ACM Classification Keywords
H.5.3. Information Interfaces and Presentation (e.g. HCI): Group and Organization Interfaces

INTRODUCTION
Much research within CSCW focuses on the transition from paper-based work practices to integration with a digital system. Organizations are often hopeful about the idea of going paperless, yet there are many unexpected consequences of this change, and paper rarely disappears entirely from the task [31, 11]. There are changes in how information is represented, stored, and disseminated. Metadata for paper (e.g., penmanship, margin notes) is different from metadata for digital documents (e.g., timestamps, file types). New policies may be required for who accesses digital information, when others may make changes, and how these changes propagate throughout the broader system [4].

One context in which extensive paper-based documentation occurs is early childhood education. The present research takes place at one early childhood education center affiliated with our university. We focus on the practice of completing the California Desired Results Developmental Profile (DRDP) for each child, a paper-based portfolio of development. Teachers and administrators at this school are enthusiastic about “going digital” with DRDPtech, a new web-based system for teachers and administrators to enter developmental ratings for children. The web interface replicates the paper-based DRDP rating forms teachers currently complete. All information fields, measures, and rating scales are the same as on paper. Administrators and teachers see many possible benefits from moving to a web-based system.

“DRDPtech...will be online and it should be pretty cool because we should be able to transfer the information from one classroom to another when the child moves up... Hopefully it will lessen a lot of this paper work... Eventually all the data that they put into the computer will automatically prepare these [overview sheets].”
–School Administrator

Teachers and administrators are enthusiastic about DRDPtech because it promises easy aggregation of data across children and over time. The system generates graphs to illustrate developmental trajectories and may help pinpoint areas for improvement. This optimistic view of the system highlights potential advantages but neglects the details of how teachers accomplish documentation work. We combine 10 months of classroom observations with detailed interview data to understand current documentation practices and potential challenges of this transition. Sellen and Harper [31] explain:

It is only by looking carefully at people’s interactions with paper artifacts, and with the digital technologies they have to hand, that we can hope to predict the circumstances under which they might be willing to give up paper.

Our analysis highlights the importance of both paper and digital media in documentation of early childhood development. Currently, observations of development are recorded on paper in a variety of ways, and throughout the documentation process observations are intertwined with photo data. A critical piece of this practice relies on the use of photos as an anchor for the teacher’s memory of an episode as well as a way to more objectively represent the child’s progress. Photos, often printed on paper, are pervasive throughout the documentation process and serve as a critical cognitive resource for teachers. Interestingly, DRDPtech does not support uploading or linking of digital photos or scanned documents.
We analyze current documentation practices in light of the online system that will be in place over the next year. While we discuss the opportunities and challenges for one specific context, our analysis contributes to the broader literature on transitioning from paper to digital records and highlights the needs and constraints of various actors in this context.

RELATED WORK
Much work examines how individuals and organizations keep records of activity, access and share this information, and transform it over time. Records serve as coordination mechanisms [29] and allow decisions and commitments made during the work to persist in time [7]. Goody [7] also notes that written artifacts can be brought into interaction to clarify ambiguities and settle disputes. Suchman [34] observes that standard procedures help workers understand what things should be part of the record, and not necessarily how or in what order they should arrive there. That is, people may go back and construct orderly records to demonstrate compliance with standard procedures in place.

Paper-based documentation practices are of particular relevance to the present research. In their seminal work, Sellen and Harper [31] detail the many affordances of paper including how it supports collaboration, information sharing, and communication. They highlight the goal of designing workflows through which paper and digital media work in concert with one another instead of trying to eradicate paper altogether. Paper documentation plays an important role in safety critical tasks such as airline flight operations [24, 27]. Heath and Luff [11] describe medical practitioners who use paper medical record cards in lieu or in addition to an electronic system. The use of paper medical cards is a socially organized practice and critical to physicians' reasoning processes. Ackerman and Halverson [1] examine the distributed nature of organizational memory of a telephone hotline, describing the changing states of information through mental, paper, and digital representations. Furthermore, there are different ways in which people share and collaborate through paper versus screen-based documentation [23].

The structure and format of the paper record, or its template, critically shapes documentation practices, and more importantly, it shapes how people reason about and accomplish the task at hand [11]. Such structures are instrumental in reducing the complexity of the work by providing constraints to the conduct of the actor [16]. In a similar vein regarding checklists, Norman [28] argues that “the fact that the preparation of the list is done prior to the action has an important impact upon performance because it allows the cognitive effort to be distributed across time and people.” However, we note that such a checklist predetermines what should be considered part of the record. We observe many artifacts and cultural practices in the present research that help divide the task of documenting development among different people, various representational states, and over time [16].

Documentation in Educational Contexts
The central focus of this work is documentation practices within early childhood education. Early childhood education centers typically support children from birth to age 5 (or just before kindergarten). Seitz [30] states that, “the documenter is a researcher first, collecting as much information as possible to paint a picture of progress and outcomes.” Here the documenter is most often a teacher, teaching assistant, or administrator. Documentation may include:

Samples of a child’s work at several different stages of completion: photographs showing work in progress; comments written by the teacher or other adults working with the children; transcriptions of children’s discussions, comments, and explanations of intentions about the activity; and comments made by parents. [17]

In some educational communities, particularly early childhood education, there has been a pedagogical shift from measuring development through standardized tests to conducting observational reports that track development. As part of this pedagogy, classroom activities are initiated by the children and self-guided. This is central to the Reggio Emilia Approach [5, 13], which is a core philosophy of the school described within the present research. A unique contribution of the Reggio Emilia Approach to early childhood education is the use of documentation of children’s experiences as a standard part of classroom practice [17].

While factors such as cost, effort, and time must be considered, there are many arguments for this style of assessment over standardized tests. In particular, this approach may produce more authentic evaluation of learning [35]. Documentation also allows teachers to reflect on and refine their instructional practices [21], thus enabling an evolving curriculum negotiated around children’s needs [30]. Many early childhood educators document development and learning in a variety of ways, and most use this evidence to communicate with families [3]. The key, however, is to provide “authentic” evidence of the young learner’s growing competencies [30]. The goal is to make learning visible, and Helm et al [12] refer to this as providing “windows on learning.”

The current analysis focuses on the transition from paper to digital documentation, but the idea of maintaining an electronic portfolio of learning development is not new. For example, electronic portfolios such as the Progress Portfolio [22] and ePEARL [26] were designed to support students in planning and evaluating their own learning. Here we examine portfolios for teachers rather than student reflection.

Capture and Access Technologies
There is a growing use of digital media (photos, video, sensor data, etc) as mechanisms to document daily activity. As an extreme case, Bell and Gemmell [2] describe documenting years of activity using a variety of sensors and recording devices. There is evidence that revisiting collections of photos captured via a SenseCam can stimulate and rehabilitate autobiographical memory [14]. Marcu et al [25] examined wearable cameras worn by children with autism as a way to help parents understand the child’s daily experiences and needs. Hayes et al [9, 10] also describe the design of capture and access technologies for understanding development of children with autism. Kientz et al [20] analyze family
needs around record-keeping for health and wellness of children, and based on this they introduce KidCam [18] and Baby Steps [19] as capture and access technologies aimed at tracking development. While space precludes a full treatment of related work in this area, the analysis presented in this paper provides a foundation for developing future documentation systems within early childhood education classrooms.

**METHOD**

This research takes place at an early childhood education center affiliated with our university. The school applies the Reggio Emilia Approach, specifically by encouraging child-initiated exploration and measuring development through documenting experiences. It is a state subsidized center and provides care for 210 children age three months to just before kindergarten (five years old). The school has 38 teachers spread over 10 classrooms. Names of teachers are not disclosed, instead teachers are identified by a single initial and their classroom age group (as noted in quotes below). Photos of children’s faces and names are blurred to protect their identities. The research team obtained IRB approval prior to this study.

**Field Observations**

Our research team has been present at this field site for 10 months conducting regular classroom observations. Most of our observations were conducted in one classroom for children age four to five, although we have made observations at each grade level within this school. Focusing on a single classroom allowed the research team to observe the daily activities of teaching staff, children, and parents within a focused setting. As participant observers, we worked with children during center time, including an arts and crafts table, a reading area, a computer center, and free play outside. In this capacity we observed many classroom practices, and most salient was the process of documenting development. Teachers wrote notes on clipboards and took photos of children with a digital camera. Some teachers annotated a child’s artwork and filed it away as part of their development. Following these initial observations we initiated a deeper exploration of documentation practices more broadly within this school, specifically how teachers complete the California Desired Results Developmental Profile (DRDP).

**Interviews**

Building on our field observations, we conducted 12 interviews with nine teachers and one supervisor at this early childhood education center. Interviews were conducted in a semi-structured fashion and focused on the process of completing the DRDP. Two teachers were interviewed twice to follow up on their process of photo documentation. Teachers were asked to select one child’s portfolio that they were completing as part of their regular documentation practices. We interviewed teachers individually and had them walk us through the portfolio. Two researchers were present and took notes during the interviews. All interviews were video recorded and then later transcribed. Interviews lasted 20-45 minutes and were conducted at the school.

**Method of Analysis**

We combine sustained in situ participant observations with teachers’ detailed accounts of completing development portfolios. Our approach is informed by theories of distributed cognition [16, 15], in which we focus on the larger system of activity and attend to the transformation and propagation of information over time. All field notes, interview data, and photo and video records were reviewed in detail and then synthesized to develop themes. Our goal in this work is to understand how teachers accomplish the task of documenting development for young children and to identify opportunities and challenges in how they go about this practice, particularly with respect to the pending introduction of the online system.

**RESULTS**

Teachers and administrators at this early childhood education center are optimistic about a new online documentation system that will be introduced over the next year. This system will purportedly help teachers and administrators track developmental progress of individual children as well as analyze classroom- and school-wide data about development. Currently, however, the school uses predominantly paper-based methods to document development. This allows our research team to examine the details of the current paper-based recording system to anticipate challenges and opportunities for the online system. We present a detailed account of how teachers make observations of learning as well as document and share information regarding development.

**Desired Results Developmental Profile (DRDP)**

Documentation of development is only one aspect of a teacher’s work at this school. Most classes have two to four teachers. Each teacher is assigned a group of three to eight students depending on the age group. Children are assigned to these groups upon entering the class. Among their many tasks, teachers are responsible for the specific needs of students, including observing development, completing the DRDP, leading parent conferences, and customizing curriculum based on student needs.

The DRDP is completed 60 days after the child has joined the class, then again in six months, and once more 60 days later if the child is still in the same classroom. Some students may have three assessment periods within a single classroom. The DRDP is state-mandated for children who receive subsidized tuition, although at this school teachers complete the DRDP for all students. It is the primary mechanism for documenting all aspects of development of children within this school. The state provides printable PDFs containing rating scales along 35 dimensions for infants and toddlers (birth to 36 months) and 43 dimensions for preschool children (age 3-5).

There are several audiences for the DRDP. At the highest level, the state may audit DRDPs to ensure appropriate documentation is being maintained. School administrators also review individual portfolios. Administrators analyze results of the DRDP in aggregate to set curriculum goals. Teachers are the main creators of the portfolios, and they are also a primary audience for viewing this information. The assessments build on each other, or at least teachers suggest that

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1http://www.wested.org/desiredresults/training/form_drdp.htm
they should. A child’s portfolio will evolve and continue to accumulate assessments over their time at the center, potentially containing five years of data. Finally, parents view their child’s DRDP as part of parent-teacher conferences. Parents are rarely given access to the entire portfolio and are instead shown a high-level summary about development that is based on data in the portfolio.

Completing the DRDP is a multistep and continuous process. Teachers observe children’s activity in the classroom area, record what they see and hear children do, store this information or evidence in various formats, review and organize the evidence, analyze the evidence against standard developmental measures, and finally develop interconnected paper trails that link pieces of evidence with various measures. At different points in this process, information is shared with other teachers, parents, and administrators. Figure 1 illustrates this process of transforming a child’s behavior and speech into actionable evidence that drives assessment.

Observe: Gathering Evidence of Development
Gathering evidence of development is the foundation for this documentation practice and central to the ultimate product of a DRDP portfolio. Several teachers use the word “proof” to describe evidence of learning. Identifying proof is a skilled practice of looking [6] that requires training and experience. Teachers are constantly observing children in the classroom and documenting their interactions with other people and the environment. Much time and care is spent making and documenting observations of children.

“It’s not something I like to say ‘okay I’m going to observe you in a week and have all these answers’ cause I want at least a month. It’s important for me to get that longevity into it.” –M, 2-3

Types of Evidence
Teachers gather three primary types of evidence: written observations (behaviors and quotes), photos, and work samples. Observations are written on paper and describe what a child accomplished, their reaction to an event, or at times even adverse behaviors. Teachers often write down quotes from the children to elaborate and supplement written observations.

“[Quotes are] a really good way of presenting evidence... it comes directly from the child versus ‘I think that Johnny enjoys dinosaurs’.” –L, 4-5

The most pervasive form of evidence is photo documentation. Each classroom has a digital camera that teachers use to document behaviors. Teachers may accumulate hundreds of digital photos for a single child. They described many benefits of photo documentation, particularly that they can easily take photos and then do not need written observations of an event. Several teachers report that photos are their preferred form of evidence.

“I take a lot of photos... I like photo observations the best because I think it captures certain things. Captures it better.” –N, 2-3

“We get a lot of the observations through pictures, which is really key... The pictures help so much.” –M, 2-3

Photos provide valuable evidence of development as well as serve as memory aids for the teachers completing the DRDP. Revisiting and analyzing the photos is an interesting part of the larger process. We describe the organization, manipulation, and analysis of photos in more detail below.

Samples of artwork and writing are additional evidence. We observed teachers in classrooms collecting artwork for this purpose. Teachers annotate these work samples, most commonly with the child’s name and date. Quotes and commentary from children may be directly added to artwork, which then becomes additional data about that activity. Work samples are included less frequently than other forms of evidence. They are most prevalent in portfolios for children age four and older. Our analysis focuses primarily on the qualities of written observations and photo documentation that are pervasive throughout the age groups.

Learning to Make “Good” Observations
Teachers skillfully watch child interactions [6] for indicators of developmental progress. One teacher said that making observations “just becomes part of our day.” A critical technique in how teachers make observations is by narrowing their focus to a small subset of children. Teachers indicate that focusing on a small group (3-8 children) helps them...
know the children better and attend to critical episodes of activity. Teachers also use concrete examples of behaviors (provided in the DRDP) that map to various measures and ratings as scaffolding while learning to observe. An example of the highest level of “shared use of space and materials” is “while coloring with crayons, offers a crayon to another child”. Over time teachers learn to generalize beyond specific examples.

An administrator reported that one challenge is teaching teachers to make “objective” observations. Teachers receive training on how to make observations that clearly illustrate a behavior without a layer of interpretation, although such records are always inherently subject to one’s interpretations formed by socially and culturally rooted practices of looking [6]. Teachers describe this learning process.

“The biggest thing that I had to learn... is not interpreting what you see, so I might see a child crying because they fell down or whatever... I don’t want to interpret that... Sometimes I would write ‘they were sad because they fell’.” –A, 1-2

Teachers seek authentic observations that occur naturally within the classroom [30]. They do not want to setup an activity just to observe a particular aspect of development, which is central to the Reggio Emilia Approach [5, 13].

“I don’t want to feed them something that they don’t come up with on their own. I just don’t think it’s accurate.” –M, 2-3

“I want it to be authentic. I never a tell a child ‘oh here use the marker’ so I can get a DRDP note.” –A, 1-2

Another key component of good written observations is making a record shortly after the episode of interest. Teachers have many responsibilities outside documenting development: they are busy carrying out lesson plans, handling conflicts, and generally running the classroom. Documenting fleeting observations is a challenge. As soon as they get “off the floor” they write observations. Teachers describe relying on their memories of the activity whether they record it immediately following the event or later in the day. In addition, teachers express the value of photos in reestablishing context around a particular episode of activity.

“I’ll see it and instead of writing it down to where later I gotta get more context, I just go take a photo of it... I don’t have to leave the floor... I prefer to take a photo of it cause it’s a lot easier to just come back to it later.” –N, 2-3

“I try to pick a photo where I can really remember and it’s really stuck in my mind what he’s been doing.” –C, 2-3

**Record: Written Observations and Photos**

Making a record of activity is a critical step in the larger process. Teachers do this by writing notes and taking photos.

**Paper Observation Logs**

Teachers systematically list observations and quotes from children on a paper observation sheet (Fig. 2). Observation sheets may be out in the classroom for easy access. Some teachers attach them to clipboards and carry them around the classroom. Teachers have created their own versions of the observation sheet, each with a similar format including the date, measure numbers, and the observation. Some teachers keep observation sheets for each child and write directly on those logs. Other teachers keep a teacher-specific log sheet.

**Scratch Paper and Sticky Notes**

While some teachers record their observations directly onto a paper observation sheet, many teachers use scratch paper and sticky notes to record observations.

“I constantly make notes, either at the end of the day or just on scratch pieces of paper, that way I can add them when I have time... I have a little caddy of books so I might have a piece of paper in there.” –M, 2-3

“If somebody mentions something, I’ll write it down on a piece of paper and throw it in my box...” –N, 2-3

“I find myself writing on stickies and then putting them in my pocket or if I have a clipboard writing on there...but occasionally those papers get missed placed... I have a note somewhere but where did I put it? Why isn’t it in the file? I should have put it in the file right away.” -I, 3-4

The use of scratch paper as an intermediary before the official observation sheet helps preserve details of the interaction. This is an especially important step in remembering the details of what children say.

“If I’m not going to remember the words then I’ll write it on a little stickum, then I’ll put it in her folder and I’ll write it in [the observation sheet] afterwards.” –G, 4-5

“If I have a conversation with somebody, the second that it’s over and they walk away... I write it down sort of like a script, like a movie script.” –A, 1-2

With early language development, teachers note that it is important to preserve the characteristics of the child’s speech, and they do this when making notes on paper. For example, if a child says “the wheels on the bus go wound and wound,” they would write down “wound and wound” not “round and round.”

**Digital Photos as Observations**

In addition to making written notes, teachers working in the classroom take photos of children engaged in various activities. Several teachers keep digital cameras with them throughout the day, others keep a shared camera on an easily accessible shelf in the classroom, and one teacher brings in her personal camera to ensure access when needed.

“I pretty much wait for the action to happen, okay grab the camera... It’s usually on the desk right inside the door that leads from
the outside, so we can either reach around and get it or ask some- one to get it.” –M, 2-3

“I carry the camera around with me. We have a classroom camera and I also bring my own personal camera... because if [another teacher] is doing a project and she wants to take pictures of the kids and I’m outside with a group of kids and they’re doing something really great, I want to capture that too. I don’t want to let it go to waste, so I use two cameras sometimes.” –A, 1-2

Teachers take multiple photos to highlight specifics like motor movement or the focus on a child’s face as well as to illustrate the sequence of activity.

“I’ll take pictures...so you see his whole body, so you know it’s [child], and then I’ll zoom in on his hand... I try not to just take a picture and then walk away. I keep going, so like a flip book...I try to make as many sequence shots as I can... Sometimes the camera doesn’t work that fast...” –A, 1-2

“I wanted to demonstrate with the photo the problem solving skills. If you just had this [one photo] you could claim, you know, he’s solving a problem...but with both photos it clearly shows he had a problem and how he solved it. Just makes it even clearer to the observer.” –N, 2-3

Photo sequences capture the state of interaction over a period of time. Teachers note that this technique highlights the process rather than the product. For this reason, photos of the artwork creation process, especially with infants and toddlers, are often used instead of just the final artifact.

**Review, Rewrite, Organize, and Manipulate**

Teachers spend time reviewing, rewriting, and organizing their evidence. Observations written on scratch paper and sticky notes and even temporary observation logs must be transferred to an official observation sheet. Rewriting observations was described as “busy work” by one teacher, yet teachers seemed to value neatly written comments in portfolios that are ready to share with supervisors, other teachers, or possibly parents. Observations must be grouped by child so that the observation sheet can be filed into that student’s portfolio. Teachers report that they are required to write up observations once per week per child. We found that several teachers rely on an accumulation of jotted notes throughout the week and then transfer them to the observation sheet in one sitting. They may do this on the weekend at home, as many teachers do not have sufficient time during the day to complete this part of the process.

At various points during the documentation procedure, but particularly when they begin to complete a child’s DRDP, teachers manage, organize, and review their collection of digital photographs. This is a multistep process that involves loading photos onto the computer, deleting unwanted photos, organizing them by child and then perhaps further by date, selecting a subset of photos for a particular child, and printing them on paper or inserting them individually into Microsoft Word documents. The vast majority of teachers print out a collection of photos on paper, cut them up, and tape them into the portfolio. Teachers have one computer per classroom as well as a computer in several break rooms that they may use to upload and print photos. There is one centralized color printer available for use. All photos are printed in color with the date on them. We were surprised by the volume of photos teachers have for each child as well as the variation in how teachers organize and review their photos. Often we observed teachers with 100 to 200 photos per child that they accumulated over the past months from which they select a small subset (as few as four photos, but typically between 10 and 15) to include in the portfolio.

**Select and Analyze Evidence**

Teachers accumulate more data than they can include in the portfolio. They make decisions about which observations and photos to include as part of the assessment. This part of the process is completed using two standard format templates (one for observations and the other for photos); however, with both forms we observed custom variations created by teachers. These variations contained the same information fields but had a slightly different layout. These forms serve as boundary objects [33] and provide a common structure that is understandable by various stakeholders who may interact with the portfolio.

**Observation Sheets**

We found several formats of the observation sheet that appear in a child’s folder. The vast majority of these observation sheets include a space to write measure numbers that could be satisfied by this observation. Teachers fill in the measure numbers at various times. Experienced teachers write down measure numbers from memory and only occasionally look up missing items.

**Photo Documentation Form**

Teachers select certain photos to include in each child’s portfolio. Most teachers use a printed photo documentation form that is part of the DRDP. With this they cut up photos and tape them to the documentation page. We encountered two teachers, however, who create their own version of the form electronically with Microsoft Word (see Fig. 3, right).

“I like to do it this way because I have the pictures on the computer and I can just...take it from my folder of pictures and put it onto the Word document and then write my captions that go with it rather than cut and glue and or tape and all that...” –L, 4-5

In contrast to digital templates, working with paper photos allows teachers to lay out sequences of photos and then attach
the group of photos (typically stapled together) to the page. We observed teachers quickly flipping through and organizing stacks of paper photos as they matched them with various measures of development.

When Written Observations are Better
Digital cameras provide an ease of capturing rich information about an activity, and photos are the preferred method of documentation by many teachers. However, photos are not optimal for all interactions or all times. Self and social development standards (e.g., relationships with adults, conflict negotiation) are particularly difficult to capture through photos because these tend to be more conversational or relationship-based. Teachers need to document when a child is part of a conflict yet they cannot leave the situation to get a camera. Instead they rely on after-the-fact written reports of the episode. Similarly, the teacher in the infant room is the sole person responsible for observing development in six babies (age 3-12 months). She reports that it is challenging to capture behaviors in this age group because infants may do certain actions infrequently. She is busy attending to the infants and cannot always get the camera. The opportunity may pass before she has time to document it through photos, so written observations from her memory of an event are valuable.

Link and Synthesize Evidence
Hand-written observations and photos are continuously gathered, organized, and analyzed in the classroom. The integration of evidence into a child’s DRDP usually occurs during the weeks just before the portfolio is due. Central to the DRDP is rating children on various standards using a paper form (Fig. 4). Infants and toddlers (birth to 36 months old) are rated on 35 measures using a five-point scale (responding to reflexes, expanding responses, acting with purpose, discovering ideas, or developing ideas). Preschool children (age 3-5) are rated on 43 measures using a four-point scale (exploring, developing, building, or integrating). This is likely the point in the process where teachers would interface with DRDPtech. Before rating a child, teachers described reviewing all of their observations, quotes, work samples, and photos.

“I actually go through all the picture ones first and then I go through the written ones and then I kinda just decide on the things... I kinda go through, I’m looking at observations and I’m filling in bubbles based on where they are on specific standards.” –N, 2-3

Linking Evidence with Measures
For each measure, teachers must provide evidence of their rating. They do this by writing a note that redirects to a specific observation, a photo documentation page, or a work sample. The critical information in this linking is the type of evidence and the date. Figure 4 provides an example of this linking between multiple parts of the paper record. Teachers may have multiple pieces of evidence for a single measure, and also have multiple measures for a single piece of evidence. Through this process teachers create a web of interconnected pages, as illustrated in Figure 4.

Synthesis and Curriculum Planning
Teachers and school administrators calculate developmental progress for individuals, classes, age groups, and the school as a whole. They use these calculations to plan and tailor curriculum. Aggregating ratings from these paper forms and deriving new goals based on this data is a challenge for teachers and school administrators. Currently this is done on paper and then transferred to Microsoft Excel for further analysis. Teachers are responsible for contributing data on each of their children for the aggregate reports.

Communication and Information Sharing
Documenting development in this context is a seemingly independent process with one teacher held responsible for the portfolio. We observed, however, three themes around communication and information sharing involving DRDPs.

Sharing Among Teachers
Within each classroom teachers constantly discuss the children and their development. They do this informally as well as during scheduled weekly meetings. Teachers primarily focus observations on their own children but will call another teacher’s attention to an activity or share data when the other teacher’s child is involved in a joint activity. In terms of more direct support in gathering evidence, school administrators and teaching assistants occasionally provide teachers with observations and quotes.

“Occasionally our teacher assistants will be helpful enough to say ‘oh here, here’s what I caught from your children today’ and they’ll have time to do that for us... Recently we’ve had a teacher’s aid in our class that handed me a piece of paper and said ‘here’s some quotes I got from your kid’.” –M, 2-3

Teachers also work together more directly to complete the DRDP if the child transitions between two primary teachers during the assessment or if the child’s native language is different from the teacher’s. Finally, teachers share digital photos (on the camera and computer) as well as printed photos. They are careful not to delete photos from a shared camera without checking with others in their classroom.

“I don’t just print my kids’ [photos]. I keep every single photo we have in the computer so that way if someone else wants one too, I can tell them ‘oh yea go in my folder, you can print out some for your kids too’.” –A, 1-2

Information Sharing with Parents
Parents are a primary audience for the DRDP, although the full portfolio is not shared with them. Teachers state that the rating scales may be overwhelming or misinterpreted as grades by parents. Teachers make decisions about which information to present to parents and how to message their findings. After completing the assessments, teachers generate a summary report (either written by hand or in Microsoft Word) for each child. This summary is filed into the child’s portfolio and shared with parents along with printed photos. Teachers pull out photos to illustrate points and even give parents photos during the conference. A goal of the conference is to have the parent agree on the summary report. Parents have a space to add their own goals for their child and to sign regarding the summary sheet. According to teachers, one difficult message
to communicate with parents is when there may be a developmental delay with a particular child. Reviewing a portfolio can give clues about developmental delays or behavior problems [20], and teachers do this to look for patterns over time.

Accumulating and Sharing Information Over Time

At any point a school administrator or auditor may access the portfolios to ensure proper documentation is in place. Portfolios must remain in a condition where information is ready to share with outside observers. More interestingly, however, the portfolio is an evolving record of the child’s development. Teachers add to the portfolio as the year goes on and as the child transitions to each new classroom. This record serves as a reference for teachers as a child moves throughout the school. With multiple teachers contributing to a single portfolio over time, there are challenges with consistency in documentation. Teachers say they may ignore previous evaluations if they differ greatly in format, are lacking in some way, or the ratings seem incorrect.

“Because everyone kind of thinks that they’re doing the best that they can do and their own format and you know their own way, then it becomes a problem because then other people say ‘well no that’s not how I do it in my classroom’ so therefore it’s filed. It’s tucked away... Why waste all this work and all this information that somebody worked so hard on...” –L, 4-5

DISCUSSION

This is the first phase of a larger research project that studies the transition to an online documentation system. We now review our key findings and, in light of these, discuss implications of DRDPtech and design alternatives.

Needs and Constraints

The teacher’s primary role is to interact with the children. There are many issues a teacher must attend to within a classroom in addition to watching for episodes of activity that signify a child meeting a developmental standard. Furthermore, their attention is spread among a group of children. They cannot easily leave to document an activity or manage a device that requires great attention. They lack time to learn or deal with more complex technology (even video cameras). Teachers strive to setup classrooms that promote exploration and self-guided learning. Similarly, in their documentation practices they aim to preserve the authenticity of child interaction with others and the environment. Quickly jotting notes on scratch paper that can be tucked away provide the necessary discreteness and immediacy. Documentation technologies should not take away from or disrupt the classroom.

Many teachers have developed strategies to quickly capture and preserve the details of interaction. Most often they do this by writing brief notes on paper or taking a photo. There are challenges in this, such as misplacing the paper note, misremembering details of the interaction, or the episode of interest ending before the teacher can get the camera. When possible, the use of digital photos helps address these challenges by providing a rich, detailed record that aids recall of an event. The digital camera itself is a key documentation tool for teachers. Digital cameras are small and portable devices that quickly capture valuable context and automatically timestamp observations. Teachers use photos (both digital and printed on paper) as reminders about an episode of activity. Sequences of photos illustrate the process a child engages in rather than just the final product. Teachers spend time printing and organizing hundreds of photos. In paper form, these photos are shared with and even given to parents and other people who review a child’s portfolio. The photos act as conversational anchors [32] among teachers and parents. Paper photos afford spreading out on a surface, stacking, and annotating. The backs of paper photos may hold notes about the activity or relevant measures. Stacks of paper photos are organized into flip books illustrating an interaction sequence.

While photos are critical to documentation, certain measures that are more conversation-based are captured through a hand-written transcript. Teachers make written observations for many reasons (e.g., to capture a conversation, no access to a camera, document a memory of an event). The process of making, documenting, and analyzing written observations is lengthy and time consuming. Teachers need solutions that facilitate more efficient transitions between various steps.

A teacher can improve their efficiency by making observations that apply to multiple measures. Photos are particularly useful in this case because of the detail captured by an image. A single photo observation form may satisfy several measures. Building the connections between a piece of ev-
idence and a measure is a challenging part of the process. Teachers spread out pages of paper documentation, pointing and highlighting the ways in which the data fit together. Some teachers, however, disregard prior evaluations if the portfolio has a different format than what they use, appears to be lacking in depth, or contains incorrect ratings (developmentally too advanced for the age). Much effort and data is wasted because of inconsistencies among classrooms.

Parents play a central role in monitoring and improving their child’s development. Moreover, they want help recording information about development and need tools to assist with this [20]. While many parents are in constant communication with teachers about their child’s progress, when it comes to the DRDP, parents only play a peripheral role and see a filtered view of the final product. There are interesting research opportunities in how to more effectively involve parents.

Implications of DRDPtech

While DRDPtech has yet to be formally introduced in this school, our analysis of the system indicates that it only directly supports the latter phase of the documentation process where teachers rate children on each measure and share information with supervisors or other teachers. Teachers go to great lengths to document development and establish clearly traceable steps in their evaluation process. These aspects of the process are not directly supported by the system, and teachers may need to continue their elaborate paper-based practices. “Going digital” may in the end conflict with and hide the richness and detail in documentation.

One salient concern is that DRDPtech does not support uploading of photos or scanned images, data that are central to this process. Simply including digital photos in DRDPtech is a natural next step; however, the affordances of photos printed on paper should not be overlooked. Another concern is that DRDPtech lacks a way to link multiple measures with a single piece of evidence and multiple pieces of evidence with a single measure. With DRDPtech, the work of linking evidence with measures must be done in preparation rather than by means of the online system, as Suchman [34] describes.

A natural question to ask is whether this school needs a new system at all when clearly this transition will present many challenges. One perceived value of DRDPtech is that it will help standardize certain aspects of documentation. Specifically, the system should improve timeliness of entries (or at least better awareness about late entries) and shared access to data over time. However, with this transition, many of the nuances in how teachers record and analyze evidence may remain but perhaps become hidden by the online system making it difficult to assess documentation quality [11].

A related question is how the technology may redistribute or create more work for the teachers. DRDPtech will certainly redistribute the work of lead teachers and administrators tasked with aggregating and visualizing data. Since the system will track the timeliness of entries, teachers will have harder deadlines for reporting and may be forced to complete the portfolios on their own time at home. Teachers also noted varying levels of technical ability among the staff. DRDPtech is likely to add more work for less tech savvy teachers, and several teachers described how much easier it was for them to create reports on paper than the computer.

Finally, it is unclear how DRDPtech will impact information sharing with parents. Parents do not have access to the system and teachers may ultimately still print out paper copies of the reports to share with parents. Teachers currently do not give parents full access to the portfolios because they do not want to overwhelm parents or make them feel as if their child is being graded. These challenges still exist with DRDPtech.

Design Alternatives

The richness of the documentation practices observed in the field generates many ideas for design. Although our team has yet to influence the design of DRDPtech specifically, we describe several technology-based solutions that could support teachers’ needs and work in coordination with the system.

One promising solution involves a mobile application for a tablet or smart phone. This would allow teachers to take photos or videos of children and immediately tag children appearing in the scene (automatically with face recognition or manually), select relevant measures, and add text or audio annotations. They could also flag content for sharing with parents. Teachers would need to carry the device around with them as they do their digital camera, but this type of device may present an additional distraction to students.

Another design direction involves digital pens that preserve the affordances of paper and provide the ability to easily upload data to digital environments. This has potential to help bridge between paper and digital recording practices. Certain digital pens have the ability to link audio recordings with handwritten notes, enabling a teacher to capture what a child is saying in time with notes about its significance.

As another alternative, classrooms may be instrumented with cameras to selectively archive episodes of interest [9]; however, this may not provide the necessary resolution for fine-grain interactions. Wearable cameras as in [25] may provide better detail about a child’s experiences. The fear of surveillance by teachers and students may interfere with the benefit of the evidence gathered [8], although some work has shown this to be relatively unfounded [9]. Similarly one can envision a Google Glass style camera that not only frees the hands but is always available and being head mounted is directed to where the teacher is focusing.

CONCLUSION

This research examines the documentation and information sharing practices of early childhood education teachers. We describe the ecology of tools used in this practice, including pervasive paper notes and digital photos. We seek a deeper understanding of how various media contribute to the documentation process. As an essential first step, we have begun by documenting teachers’ practices in the many and varied activities involved in early childhood education. It is clear that there are many opportunities to improve the design of

2 www.anoto.com
3 www.livescribe.com
4 plus.google.com/111626127367496192147/posts
both paper and digital tools to augment this process and associated practices. We hope this analysis of the documentation process will serve others confronting the complexities of supporting activities involving paper and digital media.

REFERENCES