Understanding Children's Free Play in Primary Schools

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ABSTRACT

Various technologies (e.g., tablets, toolkits, and digital toys) are used in schools. However, they are often designed to introduce new play practices for serving pre-defined learning purposes. In this study, we are interested in constructive play '*in the wild*' and how technologies can be integrated more organically into the ways young school children are already playing. This paper presents 4 one-week ethnographic study in four early primary school classrooms (children aged 5-7). The aim is to gain insights in children's free play and identify design opportunities for technology serving children's constructive play. Our findings illustrate children's interactions with resources and peers during free play, which often involve imitations and dynamically change between being solitary and social. We observed that children's constructive play was often associated with other forms of play. On this basis, we suggest three design implications for technologies that support and encourage constructive play during fee play in schools.

CCS CONCEPTS

• **Human-centered computing** → *HCI design and evaluation methods*; *Empirical studies in HCI*.

KEYWORDS

Early childhood, play, constructive play, free play, free-time activities, design implications, design opportunities, primary school

ACM Reference Format:
Pradthana Jarusriboonchai, Janis Lena Meissner, Teresa Almeida, and Madeline Balaam. 2019. Understanding Children's Free Play in Primary Schools. In *The 9th International Conference on Communities & Technologies - Transforming Communities (C&T 2019), June 3–7, 2019, Vienna, Austria.* ACM, New York, NY, USA, 11 pages. https://doi.org/10.1145/nnnnnnn.nnnnnnn

1 INTRODUCTION

Schools in the western world have adopted technologies in classroom activities [1, 2, 26]. These technologies may come in the form of interactive exercises or games to engage children in learning in fun and creative ways [4, 6, 9]. The children are expected to not just be consumers of technologies; rather they should also know how to use them for creative purposes. According to the UK national computing curriculum [42], children, as young as primary school, are expected be able to use digital tools to design and create digital content. Furthermore, learning through making with digital technology is another strong trend [24, 25, 34]. Activities that involve making and building are argued to provide rich learning contexts and help learners to generate new knowledge [28]. Several toolkits and platforms have been designed and developed by academic research and industry to lower the entry barrier and enable children to create digital content (e.g., [5, 8, 10, 29, 34]). These toolkits and platforms often involve a certain level of programming to enable the creative use of the medium, and can therefore be used to teach children how to code (e.g., [7]).

Sometimes, learning to code has become the main focus, and being creative in designing their own digital content and projects have been moved to the back seat - not without critique: For example, Resnick, the leader of the Scratch team (one of the most used programming platforms for children), asserts that teaching children to code is not only about children learning a set of computer concepts. Instead, it is about providing children another channel to express their ideas and experiencing the creative design process [3].

This research aligns with this critique on a predominant focus on educational aims and goes even a step further by instead placing our focus on looking at how children actually play and already demonstrate creative or constructive aspects within these activities. We set aside the idea of teaching young children the logic of programming or other abstract concepts, and instead, we focus on the opportunities for children to express themselves and practice creative design processes with interactive elements. In this study, we are interested in children's free play, and in particular, the kind of play that involves using materials to create things, which is commonly known as *constructive play* [21, 27]. We investigated young children's play in primary school settings, a context where children can often still choose for themselves the activities they want to engage in. We have sought to understand the development and particular dynamic of children's constructive play. Doing so, our ultimate goal is to design technology that embraces the nature of children's play and allows them to practice constructive play as an organic part of their free play. We see this presenting an alternative to more prescriptive educational technology designs that push children into adult-led sessions with explicit learning purposes (e.g., [30]). The main contribution of the paper is the implications for

C&T 2019, June 3–7, 2019, Vienna, Austria

ACM ISBN 978-x-xxxx-xxxx-x/YY/MM…$15.00
https://doi.org/10.1145/nnnnnnn.nnnnnnn

designing technology for constructive play within children's free play.

2 PLAY AND FREE PLAY

Play helps young children advance in their cognitive, social, and emotional development [43]. While there have been multiple approaches to define 'play', the common criteria of play activities are that they are spontaneous, flexible, self-motivated, freely chosen, self-regulated, and enjoyable [22, 27]. Free play is a specific form of play that can cover broader activities than generally associated play [36, 46]. Free play as defined by the National Children's Bureau of UK is when "...children [are] choosing what they want to do, how they want to do it and when to stop and try something else" [36, xi]. Free play comes in different forms and can include activities such as pretend play, artistic activities like drawing and dancing as well as calm activities like completing a puzzle [46]. Even writing, which is typically not considered as a form of playing, can be part of free play if it is chosen by the children. During free play, children are found to be enthusiastic and engaged in their choice of activities, even if these are the same activities that they consider as work in other classroom activities [14]. Multiple forms of social interactions can occur in free play [31]. For example, children collaboratively use different materials to create things with peers as part of constructive play [10]. This also allows children to experience conflicts and learn how to resolve them [15]. Free play is a natural way for children to develop problem-solving skills, experience creative processes, and express themselves [11, 21, 36, 43, 45]. For this reason, we see much creative and educational potential in free play and therefore wonder how technology could be designed to effectively support such playful forms of self-placed exploration.

Smith et al. [38] have identified four different types of play in general, namely: *pretend play*, *language play*, *physical activity play*, and *play with objects*. Pretend play or fantasy play involves make-believe with objects and actions being decontextualized from the real setting. Language play is playing with words and sounds. Physical activity play is playing by performing physical actions and body movements, often without objects, such as for example, running, jumping, or climbing. Play with objects on the other hand, is playing that involves the manipulation of objects. If playing with objects is accompanied with a goal, then it is considered as constructive play [21]. *Constructive Play* may or may not yield a concrete outcome, as it may come in a form of hands-on inquiry [19]. Children may play with wooden blocks to build a castle. Alternatively, they could play with water in a basin and create water bubble or a fountain. Altogether, we use these four types of play loosely as a general framework to understand and analyse the specific nature of children's activities during free play.

Based on this related work, our hypothesis is that self-paced play with objects that is combined with a self-chosen goal presents optimal circumstances for creative playful learning. Given our focus on eliciting implications for technology design and providing 'smart' objects to play with, we are particularly interested in how exactly objects and other resources are used within free play and in which ways they are chosen by the children to serve a goal in the spirit of constructive play.

2.1 Free Play in School

Play and even free play are also an important part of children's experiences at school, and previous research has engaged in characterising these. Parten [31], for example, observed social participation of pre-school children during their free play in a nursery. She has identified six types of play based on the social interactions between children. These include: 1)*unoccupied behaviour* - a child is not playing, just observing others; 2)*onlooker* - a child watches other children play and actively asks questions and gives suggestions to those children; 3)*solitary play* - a child playing alone; 4)*parallel play* - a child plays independently with the same toys in his own way beside others; 5)*associative play* - children play with each other, but the play activities are not in sync. Each child acts as they wish during the play; 6)*cooperative play* - children play in a group with one or two children manage and direct how other children play in the group. Corsaro [16] also observed social participation of pre-school children during free play. Different from Parten, Corsaro focused his studies on children's behaviours when interacting with other children, describing different interaction strategies and sharing routines that take place within children's shared play. This includes how shared play is initiated between children, how children maintain their shared play and how they deal with arisen conflicts.

Wyeth [46] conducted observations in kindergarten. The observation focused on the generic understanding of young children's behaviours during free-time activities. The observed free play activities have been divided into three categories: 1)*calm activities* - such as completing puzzles, reading books; 2)*play* - such as pretend play in a home corner, constructive play with blocks; and 3)*artistic interactions*-such as crafts, painting, or dancing. She also briefly discussed participation structures between peers and the spatial organisation of these activities.

Our study revisits a research context that is similar to Parten's, Corsara's, and Wyeth's (that is, observing play practices of young-age children in settings of educational institutions), yet with a different focus and goal. We focus on children's interactions with the environment and use of resources during free play in school. This is broader than Parten's and Corsara's studies that only focus on social behaviour. Our study, in extension to Wyeth's observations, focuses on children's interaction with peers as well as surrounding resources for creative and constructive purposes. Again, our pragmatic aim is to elicit relevant implications for designing technology for constructive play that seamlessly blends in with children's free play.

3 DESIGNING TECHNOLOGIES FOR CONSTRUCTIVE PLAY

Previous work has reflected on different aspects and identified guidelines and implications for designing technologies for children. Resnick and Silverman [33] present principles for designing construction kits for children based on their own experience in designing the technology, mainly, for learning and STEM education. The principles discuss different properties of construction kits, such as *low floor and wide walls*, *support many paths many styles*, and *make it as simple as possible*. While the authors argue that the principles are also useful for everyone who design technologies for

children, the principles only provide general guidance for designing mediums and resources that enable children to design and create with technologies. The authors did not discuss any specific aspects that should be considered when construction kits are used in different contexts, e.g., in adult-led learning sessions or in children's free play.

Wyeth [46] identifies implications for designing playful technology based on the insights gained from her ethnography study in kindergarten. Her design implications emphasise that technology should be *open for different uses* and *different interaction opportunities*. She also addresses that technology should be designed to support social interaction between peers. Playgrounds are a common place for children's free play to take place. Sturm et al. [40] identify five key factors that should be considered when designing interactive playgrounds: social interaction, simplicity, challenges, goal, and feedback. They argue that *social interaction* is one of the key components in traditional playground design as well as *simplicity*, which allows children to play by themselves without any help from adults. Challenges, goal, and feedback are factors related to motivation and fun in play. However, these implications and key factors refer to general children's free play, not necessarily with a focus on constructive play.

This study adds to the previous work by focusing on the nature of children's constructive play, including interactions both with resources and peers as part of their free play. Through doing so, we also build on only a small amount of research within HCI which has sought to describe children's constructive play during free play in and around school.

3.1 Technology for Play in Early Childhood

There are several interactive technologies that are designed particularly to enhance play experiences and exploration of children. For example, FlowSteps [18] (for 7-8 year olds) is a set of interactive mats that light up in different colours to promote play and exploration when children step on them. Jogo [17] is a music generator system that children (aged 3+) can manipulate by placing and moving ping-pong balls around the play surface to play musical notes and rhythms. Creighton et al. [17] argues that the simplicity and ambiguity in its design encourages play in young children. Interactive Pathway [37] is an interactive installation in a playground for young children (aged 3-5) that responds to children's steps via spinning motors. The authors asked the children to design paper crafts, which were later integrated as part of interactive feedback given to the children when they interacted with the system. Various forms of play emerged in play sessions with children using these three systems. For example: children set up their own rules for play with FlowSteps; when playing with Jogo children engaged in both exploratory and social play; and Interactive Pathway enabled both fantasy play and game-building. However, a critical view of these systems positions the interactive aspects of technologies primarily as interactive feedback, which responds to specific actions of the children. In other words, children must adjust their imagination and play to fit the behaviours of the systems.

Some systems act as tools to promote play experience as well as encourage exploration and creation. For example, I/O brush [35] allows children (aged 4+) to pick up properties like texture, colours, or movement of different materials in the classroom and use them in their paintings. Cartoon [44] is an interactive object with abstract limbs. Children (aged 5-8) can use Cartoon to bring to life their paper drawing, recording movement for limbs and creating their own imaginative creatures. In addition, there are a number of construction kits, which allow children to design and create their own interactive creations. These systems often introduce simplified abstract concepts of, for example, programming, model making, or electronics, as another learning layer. ScratchJr [20] is a graphical programming language and an application for children (aged 5-7) to create animations and stories. Topobo [32] is a constructive block set with the ability to record and playback physical motions, designed to promote model making in children (aged 5+). MakerWear [29] is a tangible construction kit with a variety of plug-and-play electronic modules for young children (aged 5+) to create interactive wearables. These tools and construction kits indeed introduce new learning and play spaces for children, yet with a strong emphasis on learning new skills, e.g., programming. They are often used and remain in adult-led sessions with explicit learning purposes (e.g., [30]), rather than being used in free play.

Table 1: Numbers of children in the classrooms

	Reception	Year 1A	Year 1B	Year2
No. of students	31	14	30	18

4 STUDY SETUP AND METHODOLOGY

In this study, we observed four classes in schools in Newcastle, UK. Our observations were conducted in one reception class (5 years old), two Year 1 classes (6 years old), and one Year 2 class (7 years old) in 4 schools from the same poorer area of the city. All classes were mix-ability. See Table 1 for the number of children in each class. A researcher spent the duration of a week in each class during normal school hours (9:00am to 3:30pm). The observations took place in the summer term of 2017. The study follows an ethnographic approach [12, 23]. While our focus was on how children spend their slots of free time, all the activities that took place in the classroom and around other school areas were observed and documented with handwritten notes and photography. This was done to contextualise our findings and to understand how classroom activities may affect children's free play.

Our data comprised observation notes and photographs of activities in the classrooms and around the schools. The notes include details of conversations with children, as we enquired about their play. Additional interviews with the teachers were also conducted to help clarify any questions encountered during the observations. These interviews were audio-recorded and transcribed. The analysis of this data corpus (observation notes and interview data) was analyses using thematic analysis approach [13]. The analysis was deductive in the sense that we used Smith et al.'s framework [38] to identify different types of play observed. However, our analysis still retained inductive elements, in that we looked to our data to extend and expand upon just types of play, by looking at social interaction and interactions with resources in a broader sense. The coding was undertaken by one researcher, creating themes which

were then discussed with two additional researchers to solidify the interpretations of the findings.

5 GENERAL OBSERVATIONS

This section reports our general observations of the primary school environment. The observations present the children's day structure, classroom and outdoor resources, and technologies available in schools.

5.1 Day structure

The reception class (aged 5) has the most flexible timetable for school activities. A normal day in reception class includes carpet time, learning sessions, outdoor play times, snack times and lunch. Carpet time is when the whole class meets and does an activity together, such as listening to a story or watch a YouTube video. Learning sessions happen in small groups, and the teachers select children to work with them. A learning session lasts approximately 15 minutes, and children only participate in four such sessions per day. Meanwhile, the other children who are not doing any activities with the teachers can freely choose the activities that they would like to do within the classroom. In comparison, Year 1 (aged 6) and Year 2 (aged 7) classes have a more structured timetable with allocated teaching sessions, break times, and lunch time. During teaching sessions, all children work on an assignment or do activities related to a subject being taught.

All the children were observed to have several free play sessions throughout their school days. These included lunch and break times as well as so-called choosing times in which the children are allowed to do any activities that they want, using any resources available. In Reception class, choosing time happens throughout school hours when children are not participating in any group activities with the teachers. In Year 1 and Year 2 classes however, choosing times only take place if the children have finished their class assignments early or at the end of the week. The Year 1A class has an additional choosing time slot in the morning before the class starts. Generally, the duration of choosing times vary from 10-60 minutes. Lunch and break times are fixed, 60 minutes for lunch and 20 minutes for break times. Children are usually outdoors during lunch and break times whereas choosing times usually happen inside the classrooms. However, weather permitting, the teachers may also allow the children to be outdoors.

5.2 Classroom and Outdoor Resources

5.2.1 Classrooms. Classrooms are divided into different areas with the reception class having the most options of areas for children to choose. These areas are equipped with different resources (e.g., toys, games, building blocks, playdough, clothes, etc.) to allow children to engage with different environments and activities. For example, a *small world area* is supplied with building blocks, small people and animals, and dolls. The `home corner` area is filled with toy kitchenware and dummy fruits and vegetables. All areas in the classrooms are managed and controlled by the teachers. Children can access them when they are open and can freely use all the toys and items inside the areas. The teachers carefully design each area to support and promote children's learning and development. For example, a *playdough* area is there to help children practice their fine motor skills. *Water* and *sand* areas are for children to learn about mathematics, particularly the concept of capacity through play. Pens, pencils, papers, scissors, glues, and small whiteboards are additional items distributed around across the classroom. The purpose is to allow children to write and draw anywhere, not just within one specified area. However, the children's interests also play a role in teacher's decision about these areas. For example, the teachers keep the home corner area in the classrooms because the children enjoy it so much.

In addition to all the areas, the teachers also keep some spaces empty in the classroom to display children's work. This includes crafts and designs that children have done as part of classroom assignments as well as those that they have done in their own in their free play.

5.2.2 Outdoors. Outdoor areas are usually shared with children in other classes. An outdoor area usually comprises a big empty space with some paintings on the ground and playground equipment. Three of the four schools provide additional toys outdoors such as tricycles, balls, hula-hoop, jumping ropes, and clothing. Children only tend to have access to outdoor areas during lunch and break times.

5.3 Interactive Technologies

All classrooms are equipped with an interactive whiteboard. The Year 2 class and Year 1A class are the only classes that always have other interactive technologies available throughout school hours. The Year 2 class has 8 iPads and 14 laptop computers, and the Year 1A class has 2 desktop computers available to children in the classrooms. The schools also have subscriptions with online learning resources for children to use learning applications and games using the iPad and computers. The Reception and the Year 1B classes have to share iPads with the rest of the school, and the teachers have to book them in advance. Both Year 1 classes have computers in the computer rooms, which are shared with the whole school. They are only to be used for school lessons. Bee-bot[1] is the only observed technology addition to iPads and computers and that was only in the Year 1A classroom. Similar technologies were not observed in the other classes.

6 CHILDREN'S FREE PLAY

During our observations, children performed a variety of activities in their free play. We observed children engaging in reading books, solving jigsaw puzzles, talking with friends and teachers, and playing computers. In accordance to Smith et al.'s general framework [38], we observed the children engaging in different play activities: They immersed in *pretend play* using different toys and materials around the classroom, *physical activity play* outside, and *constructive play* with toy building blocks, playdough as well as paper and pens. Children were also observed to practice artistic activities, creating artworks using different medium (Figure 1). The following further describes our observations of children's free play in the lights of three overarching themes: dynamic of free play, children's interaction with resources, and social interaction that emerged as part of free play.

[1] Bee-bot: https://www.bee-bot.us/

Figure 1: Children used different tools to create artworks.

Figure 2: Left: girls playing with dolls. The girl on the right is building a bed from domino blocks for her doll. Right: boy building their Fidget Spinners.

6.1 Free Play is Dynamic

Different types of play activities were observed during children's free play including pretend play, physical play, and constructive play. However, we noticed that children's free play often involved multiple types of play at once. Children were observed pretending to be racing cars, i.e. pretend play. Simultaneously, they did actually perform a race through running, i.e. physical play. We also observed children changing from one type of play to another. Children may start off with a certain type of play, but as the activity goes on, we could observe other types. In the following, we describe how this dynamic interchanging of play types comes into action for constructive play.

6.1.1 Building a Model to Play. Children were commonly observed being immersed in pretend play as well as building models. We noticed that, sometimes, pretend play was the core of children's free play, and it motivated and created a storyline for children to build models. We observed a group of girls playing with dolls during their choosing time. The first girl was combing her doll's hair. The second girl was dressing her doll. We asked what they were doing. The second girl answered: "*I am going to take her on a tour.*" Later, she put her doll in a car and pushed it around the classroom. The third girl also answered: "*I am making a bed for my doll. When she comes back she will have a bed to sleep.*" (Figure 2-left). Similarly, a group of boys were observed building Fidget Spinners[2] (Figure 2-right). After finishing with the fidget spinner models, we also observed the boys performed spinning gestures as if they were actually using the real gadgets, despite the blade(s) of their models could not actually spin. A similar pattern was also observed in other free play sessions when they built paper aeroplane and paper parachute models.

6.1.2 Materials and a Cycle of Building and Play. Children built models using different materials from toy building blocks, play dough, to paper and pens. We observed that the different materials would also affect how the children played with the models.

Some children were observed creating models using playdough, and most of the models created with playdough represented some forms of food. Some of these models were built in course of pretend play: *a child used playdough to make a strawberry cake when she was playing cooking in the home corner.* However, when playdough was used alone, we often observed children just play with it (cutting into different shapes using cutters, making different shapes) without creating any meaningful models - i.e., general play with objects without any goal (not constructive play). In these cases, they destroyed their creations shortly after some shapes were made, and we rarely observed children playing with a model after they finished building it.

Paper presented an interesting material in regard to cycles of building models and playing with them. Children were observed creating different models with paper and playing with them after building them. We noticed that children's paper modelling only goes through one cycle of build and play. The children moved on and created a new model using another piece of paper. Two boys were observed creating aeroplane models. After they had finished their aeroplanes, they played with the models for a short moment. Then, they started to build their parachute models, leaving the aeroplane models behind and did not revisit them when they played with their parachute.

In contrast to such a one-off cycle with paper, we noticed that children went through several cycles of build and play when they were using toy building blocks. Children's model building evolved over time, and this developed along with collaboration with peers. We observed a boy was building a model with toy building blocks. We asked him what he was making. The boy answered: "*a building*" (Figure 3-1). He continued with his building for a while until the second boy came along and asked: "*can I join?*" The first boy said yes. They continued to build their model together. Later, we asked them again what they were making. This time, they answered: "*a large work tower, and these are two trees [in front of the building].*" The boys began to add animal figures to their work tower. They explained to each other what the animal figures were doing. (Figure 3-2) Shortly, the building had become a mountain with many animals being added to their model. (Figure 3-3). Another boy joined the team and they were building a new animal headquarter. Two boys were building a track around their building, and another boy was adding more animals to the track (Figure 3-4).

6.2 Interactions with Resources

Teachers set up resources around the classrooms and the playground outside, but children choose which of these resources they want to make use of during their free play. Some resources were observed to be more preferable to the children than others. Observations show that children creatively applied different resources in their free play.

6.2.1 Computers are Popular. Children were observed reading books, solving jigsaw puzzles, and using iPads and computers. However, the iPad and computers were among the most popular items for the children. Many children chose these devices as their first

[2]Fidget spinner: https://en.wikipedia.org/wiki/Fidget_spinner

Figure 3: A group of boys built a model. 1) a boy started off with his simple building. 2) the second boy joined the team. Animal figures were added to the model with some pretend play. 3) Building became a mountain. Pretend play with animals continued. 4) the boys were building a track around the headquarter.

options for their free play. In schools with a limited number of computers, children sometimes competed to use the technology, and teachers had to set rules for using them. Children were observed to race to register themselves to use computers during choosing time. Children who did not get computer spots were sometimes observed to gather around their peers to see what they were doing and gave suggestions (Figure 4-Left).

Although it is a free play session, children were supposed to only use educational games on iPads and computers from school subscription applications such as Bug Club[3] and Mathaletics[4]. Some of these applications resemble traditional book reading and jigsaw puzzles. Teachers would also usually encourage children to read books during their free play, but it was rarely the first choice of the children. However, reading is often chosen over other non-computer activities if it is done on iPads or computers. We did not observe children using any creative applications such as drawing, photo editing, or animation software. Children only used such creative software in lessons guided by teachers.

The teacher in Year 1A class, sometimes, allowed the children to use her computer under her supervision during free time. Unlike other computers, the teacher's computer is connected to a large interactive screen and already logged in with the teacher's account. The teacher computer was often occupied by a group of children. Dancing was the activity we observed when the children gathered around the teacher computer and the large interactive screen (Figure 4-Right). This dancing activity extends the class routine where everybody dances together with a music video chosen by the teacher before lunch. During free play, children could freely choose music videos they would like to dance. They decided together on a music video they wanted to play in a suggestive manner: "*let's have the three little pigs song next.*"

[3]https://www.activelearnprimary.co.uk
[4]http://uk.mathletics.com/

Figure 4: Left: a group of children gather around a computer. Right: Children danced with a video they play on the big screen from the teacher's computer.

Figure 5: Left: Two girls pretend play as they were making cupcakes. Sand is used as cake batter. Right: A girl used maths counters as food and shovelled it with a ladle.

However, not every form of technology was well received in children's free play. The Year 1A class has Bee-bots, a programmable interactive toy, in the classroom. The teacher intentionally left the toy out for children to use in their free play: "*Bee-bot is out because, first we used it in Math, when we were doing position and direction. Then, we used it in some computer lessons. We did a few lessons to teach the children how to use it. Then, that's left there if they choose to go and play.*" Despite the teacher has provided instructions how to use Bee-bots, nobody touched the toy during our observation week.

6.2.2 Adapt and Appropriate Different Materials. Pretend play was commonly observed during children's free play. Children used different toys and items in the classrooms as part of their pretend play. This includes items particularly designed for pretend play such as character dresses, cooking toys, and toy food. The children would also adapted random items for their pretend play. The Year 1A teacher state that "*if they want something and they haven't gotten it, then they pretend something else as it.*" However, we observed that children not just randomly picked an item to pretend the item they want. Rather, children were likely to use items that have properties feasible for certain actions in their pretend play. For example, two girls in the sand area explained to us that they were mixing dough for a cake batter and pouring the batter into a baking tray to make cupcakes (Figure 5-Left). Another child used play dough with toy food to make a finished version of cake. Children also used maths counters as soup, that they pour into different containers; as food, that they shovelled in with a ladle (Figure 5-Right) in home corner.

Figure 6: Left: a child was tracing the backside of a colouring sheets. Right: a child was cutting coloured pictures from a colouring sheet to create a collage.

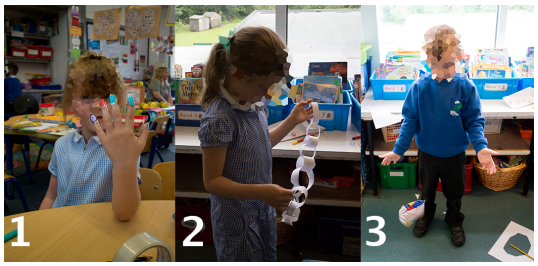

Figure 7: Examples of children's creations with paper. 1) fake nails. 2) a bracelet. 3) a parachute.

The teacher of Year 1B class provided colouring sheets for children to use during choosing time after lessons. While many children just coloured in those colouring sheets, we also observed some creative uses of those sheets. We observed many children using the backside of those colouring sheet to trace for the picture in the front (Figure 6-Left). Some others coloured in the colouring sheets, then cut out different bits from multiple colouring sheets to create a collage and enhanced it with their drawing (Figure 6-Right).

6.2.3 Children Go Wild with Paper and Pens. During our observation, children used different materials and tools to create artworks (paints, whiteboard, colour pencils) and models (toy building blocks, toys animals, play dough). However, paper and pen were the most popular tools. Children were observed not only drawing or painting on paper, they also used paper to create models, including, fake nails, bracelets, aeroplanes, parachutes, guitars, and large collage of artworks (Figure 7).

6.3 Social Interaction During Free Play

Interaction between children during free play varied dramatically. We observed children from being engaged in solitary activities to participating and collaborating in a large group. This section highlights social interactions that emerged between children during their free play.

6.3.1 Different Ways to Play Together. We commonly observed children building models and creating arts together. While children also performed these activities solitarily, we noticed that when children played together, they built larger models with a lot of elements, and everybody involved could participate in the activity. When the boys in the Figure 3 where building their model, all the children were engaged either in building or playing with the model. During

Figure 8: Children creating paper guitar models. 1) collaboratively developed ideas together. 2) Created own model. 3) played with the models.

Figure 9: Children were playing in their own play space with the same sequence of actions.

the building process, we observed that they always expressed their intentions and goals to each other when they extended the model in a certain way.

We also observed that the children played together, but each child created their own model separately. Children started by sitting in a group to develop an idea of a model together. Then, they created their own individual model, before they came back and played together (Figure 8).

Children also set up a space to play together. We observed children using P.E. items (mats, hula-hoops, jumping ropes, balancing bars, and cones) to collaboratively create their own play space for physical play. A few children acted as leaders who decide the overall concept of their play and told other children where to place each item. They also set up rules and created a sequence of physical actions which other children followed. (Figure 9).

Playing together could be spontaneous and unplanned. We observed two boys were tracing backside of a colouring sheet next to each other (Figure 10). Then, the boy on the left (Boy-A) started to draw a train track on the paper he was tracing. Boy-A connected two pieces of paper together to create a longer track. The other boy on the right (Boy-B) noticed that. He drew a train track on his

Figure 10: The boys spontaneously created an art piece together. 1) Boy-A drew a train and a train track on his paper. 2) Boy-B noticed Boy-A's track and drew a train track also on his paper and connected with Boy-A's. 3) Boy-B finished his flower tracing and drew a train on his track.

paper to connect with Boy-A's track. Boy-B went back to finish his flower tracing. Then, he drew a train on his track. They glued all the pieced of paper together to create a single artwork. Finally, they wrote their names on the middle of the artwork and gave it to their teachers as a shared piece of artwork.

We also observed children's spontaneous physical play in the playground. A child started to jump over poles and walk on balance bars. Then, other children started to follow the sequence of actions without rules being stated explicitly. As the play developed, children set rules and competed with each other for who could go faster through all the actions without making any mistakes.

6.3.2 Children Imitate Their Teacher. The children often imitate their teachers in their free play. We observed children using items in their free play that their teachers had used in previous lessons. The teacher of Year 1B class often uses a pot of name sticks during his lessons. Each name stick has a name of a child in the class. The teacher randomly selects a stick from the pot to select a child to answer a question in his lessons. During choosing time, children used the name sticks for their free play. *A small group of children played with a pot of name sticks. Children individually chose a stick for the pot. Instead of calling the name of the child on the stick aloud, like the teacher, the children wrote the names on a whiteboard. The process continued. The children did the activity separately on a shared whiteboard. Each one of them (3 children) had their own list of names (Figure 11-Left).*

Children not only use items their teachers have used in lessons. They also imitate the actions their teacher did. *The teacher of Year 1A class taught a phonic lesson using a game on the large interactive screen. She split children into teams based on their regular house teams. Every time a child can read a word correctly, the child's team get a point. The next day during free play, two children created the same score table on the whiteboard. Each created own score table next to each other. The girl on the left was the first to create the score table. Then, the girl of the right joined in and drew a line on the whiteboard next to the first girl (Figure 12).*

Figure 11: Left: A girl is adding a new name she just got from a new stick to her name list. Two boys are choosing a name stick from the pot. Right: Children created math problems for each other, then swapped to solve the problems.

Figure 12: Left: the teacher's score table (circled) for the children's phonic game. Right: the children are imitating the teacher's score table from their yesterday lesson.

Some children went really far and imitated the teacher's math exercise. *Two girls finished their maths exercise early and were allowed to free play. The two girls sat together and started to create maths problems, similar to the one the teacher just gave to them. Then, they swapped to solve each other's problems (Figure 11-Right).*

6.3.3 Children Imitate Their Peers. Imitation also takes place between peers. We observed children imitated various activities from physical play to building a model. We noticed that only a handful of children came up with new activity ideas as activity leaders, then, other children just followed. However, most of the activities were simple enough for other children to replicate. The imitations took place after other children had seen and understood the activities.

When the Fidget Spinner model was built, it started with a boy building his own. When he finished, he came to showed it to us, saying that *"here, I have built my Fidget Spinner."* Other boys saw it and started to build their own (Figure 2). The boys also extend the design of the Fidget Spinner model further by adding multiple spinning blades to the model.

However, some activities required skills, which are difficult for other children to imitate. An aeroplane model was one of the difficult activities we observed. It requires a few folding steps, and other children had some difficulties in following the steps and replicating the model. We observed the boy, who started the aeroplane folding activity, helping another boy with his model (Figure 13). Not every child would engage in imitating a complicated activity. Another boy gave up trying to make an aeroplane by himself and just asked us to do it for him. He also denied our offer to teach him to fold.

Figure 13: Children creating paper model aeroplanes. 1) The boy on the right (Boy-C) looking closely in how to fold an aeroplane from the boy on the left (Boy-D). 2) Boy-D was helping Boy-C with his folding.

After we did so upon his request, he just enjoyed decorating and playing with the plane with other boys.

7 DISCUSSION

This study extends our understanding of children's free play in school and how children interact with resources and peers as part of their free play. While Wyeth [46] have identified three types of free play activities (calm, play, and artistic) in her observations, our study underlines the dynamic of children's free play activities. Our findings show that children used different resources in both passive and creative ways (cf. [46]). We also highlight the development and dynamic of constructive play within children's free play. While we observed children performing constructive play during free play, we noted that constructive play blended in with other types of play and took place across a session of free play. Children may start out being passive, then gradually develop creative practices and constructive play as their free play progresses. For example, a child was observed playing with her doll before she decided to build a bed for it, or children were first just playing with playground equipment, then they developed sequences of actions and rules as they became more engaged with the equipment.

While the children had different reasons that motivated and influenced their designs and creations, the children constructed designs and artefacts very much on the go as part of their wider play ambitions. Thus, technology used within children's play should not be seen as something separate from the rest of a child's play. That is, technology should still allow children to play out their creativity and imaginations into tangible forms of creations that they can incorporate into their natural play practices, which may include more than just constructive play. The following further discusses and translates the findings to implications for the design of technology for constructive play that would blend in with children's free play. We also highlight aspects of social interaction between children that technology should support.

7.1 Simple, But Flexible Tools

Our findings show that children often adapted available resources for their constructive play. These resources tended to be simple materials, like paper and wooden/plastic blocks. However, they are flexible in terms of interactions and affordances as well as in supporting different forms of play. Children could draw and colour on a piece of paper. They could also cut or fold it into a shape they want. Furthermore, a piece of paper works as a paper by itself, but offers more space if attached to another piece. Also, it can be easily attached to other (play) items. Similar goes to wooden/plastic blocks. It can be inferred that technology designed for constructive play in children's free play should be both simple and flexible in its affordance and use. This assertion echoes one of Sturm et al.'s relevant design dimensions for intelligent playgrounds [40]. The simplicity refers here to being simple to use, that is, children are able to start using technology by themselves. We would further argue that technology should have simple functions (if not just one) that are straight-forward and work robustly out of the box.

Based on our observations, children exercise skills and knowledge they previously acquired or incorporate something they are already familiar with into their play. *Simple function(s)* allows children to easily get familiar with and use a technology straight away as a tool for their own purposes and modalities of learning. Young children who solidify (new) skills and knowledge through repeating and revising them in their free play are likely to choose toys and materials that are flexible enough to become whatever the children want them to be. So, if a technology is not too prescriptive and its focus is not on teaching young children any new abstract content (such as programming logic), technology that *works out of the box* allows children to focus on incorporating the technology into their wild play, instead of figuring how the technology work. However, we want to emphasise that simplicity should not be equated with a design that constricts the use of a technology. Unlike many interactive toys with a prescribed set of rigid input-output-functions, technology for constructive play should be designed so that children consider it as a flexible resource or a tool for them to play out their creativity. Rather than just presenting an interactive item they can passively play with in the way the designers anticipated, it should serve them as a robust but flexible resource for model-building that young children can use to turn their imaginations into tangible forms of creations.

Furthermore, unlike class assignments, there is no definite finish line in children's play and creations. We noticed that children continue to extend their creations until they are satisfied, then they '*play*' with them. Yet, some children revisited their creation and continued to extend it again at a later point, and by doing so, the cycle of playing and creating would continue. Alternatively, what may seem like a half-finished creation may in some situations also satisfy the play needs of a child. A created model might be good enough as long as it can be included in play despite its half-finished state. Therefore, a successful technology for constructive play should allow children to play with their creations at any point just as it is, instead of forcing the child to finish his/her creation to a level required by the technology. At the other end of the spectrum, children may want to keep adding new things to their creations later on. Technology should also continue to being open for further extensions.

Topobo [32] presents a good example to illustrate our discussion around simplicity and flexibility. It is a construction block set with the ability to record and playback motion. The kit has been criticised for being too simple as a curriculum material and too open-ended for teachers to use in classroom [30]. However, we

consider the kit as an excellent example of a simple but flexible design and should be explored in young children's free play. It comes with one function, i.e. record and playback and playback motion. Users can easily create a moving robot by snapping different blocks together. Furthermore, the modular design of Topobo (active blocks with motor and non-active blocks) creates flexibility in the model building process, similar to LEGO. Children could freely decide their own design and movement and extend it until they are satisfied.

7.2 Flexible and Extendable Social Space

Tabel et al. [41] observed that children mainly worked on their own when participating in code clubs. The children usually paid attention to their own creations and the guidance by adult instructors. This is contradicted by our observations in children's free play. Social interaction between children plays another important role in children's free play. Similar to Parten's observation [31], we observed multiple types of social interaction between the children. Our findings show that social interaction between children takes place throughout children's free play. Children may not always be collaborating, yet we often observed them reacting to each other and being influenced by their peers either directly or indirectly (cf. [31]). We noticed that children were likely to work individually if their creations were personal items (e.g., a Fidget Spinner, a guitar, or an aeroplane). Nevertheless, they were often also helping and learning from their peers. On the other hand, children were most likely to collaborate when they were working on large creations (e.g., a large art piece or a play space). Most existing construction kits for children are designed to build personal creations [29, 32, 34]. To inherently support the variety of children's constructive play practices during free play, technology should also allow children to construct larger designs and creations by, for example, including physical oversized components or props, to support and encourage group play (cf. [39]).

Our observations also show that children's state of social interaction with their peers is in a constant state of flux; their interactions changed rapidly, and collaboration could happen spontaneously. A child may start off doing an activity by him/herself, and in no time, another might join in and they would continue doing the activity together. Thus, a successful technology to support collaborative constructive play should be flexible in terms of supporting spontaneous involvement of multiple users in the creation process, a situation similar to Figure 3 and Figure 10. Furthermore, a transition from solo activity to collaborative play (and back again) is often in response to triggers from peers. Within a single piece of creation, children may try to achieve both their personal goal and a collaborative goal, which may be unrelated (a situation similar to Figure 10. Therefore, technology should be flexible enough for children to easily fulfil all goals without being forced to scarify one or another

7.3 Easily Imitated

Imitation is part of children's learning and development [38]. We frequently observed imitation in children's constructive play. Our experiences in the classroom suggests that even at a young age, some children lead new activities, while others are happy to follow. In particular, we commonly observed children being inspired to create things after seeing what their peers were creating. An example is a boy creating a Fidget Spinner model, then others followed and created one of their own. While some children merely copied, other children extended the ideas beyond the original. This suggests that technology should allow children to build through imitation, since imitation can also lead to new designs and creativity.

We noticed that most of the children imitated by merely watching their peers' actions or creations. In fact, learning can be done by watching [39]. We suggest technology designed for constructive play should give plentiful visual clues in a final creation how it has been created. When children look at a creation that was created by others, they should easily understand the underlying creation process and be able to easily replicate and extend the creation further. Current designs of several construction kits focus mostly on simplifying abstract and complex concepts only for the original process of building and produce creative media that are understandable for young children. For example, tangible interfaces are often considered for their simple and intuitive interaction technique based on natural metaphors of objects [29, 30]. We would like to encourage designing beyond children builders, and also consider how a design and creation process can be easily conveyed to other children as an audience of potential new users who would like to imitate and learn through ad-hoc replication.

8 CONCLUSION

We observed a total of four classrooms, comprising children aged 5-7 years, in order to gain a better understanding of their free play. The focus is particularly on the children's interactions with the environment and their use of available resources. Our findings showed that children's free play is dynamic and spontaneous. Children may start off with a certain type of play, then develop it into others as their play goes on. Children constructed different creations, so they could later play with them, and we also observed them adapting and appropriating different materials for this. They were very creative in using paper for a variety of pieces of arts and models. Our findings also indicate different ways that children play together, and how the social interactions between them can vary dramatically over time. We observed children engaged in solitary activities as well as playing together. Our analysis suggests that for technologies to be seamlessly integrated into children's free play, creations made with these technologies should be considered as just another component of children's wider play practices. The design of technologies should attend more closely to support the dynamic and creative nature of free play and social context of uses. In addition to merely simplifying media or interfaces, technologies should also provide flexible and extendable social space and offer simple visual metaphors to enable imitation, which is common in children's constructive play.

9 ACKNOWLEDGEMENT

We thanks for the schools for letting us conduct the ethnography research. The research is funded by the EPSRC grant for DERC (EP/M023001/1). The writing of the paper is partly funded by the Academy of Finland as part of the 'TechFashion - Design of Future Wearable Computing' project.

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