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SMART, SKILLED AND CONNECTED IN THE 21ST CENTURY: EDUCATIONAL PROMISES OF THE INTERNET OF TOYS (IOTOYS)

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Smart, skilled and connected in the 21st century:
Educational promises of the Internet of Toys (IoToys)

Synopsis:

This exploratory study investigates the relation between preschool children and smart, connected toys, which have educational promises regarding the Internet of Toys. By using toyification of education as a conceptual framework in understanding the emerging role of smart toys in the pedagogical context and play tests conducted with preschool-aged children, the authors aim to understand which kind of elements in the toys afford playful enjoyment and opportunities for learning both in terms of their physical qualities and digital dimensions.

Smart, skilled, and connected in the 21st century:
Educational promises of the Internet of Toys

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This study explores the relation between preschool children and smart, connected toys, which show educational promises regarding the Internet of Toys (IoToys). Smart environments, such as educational environments, when combined with networked wireless toys interacting with each other, computers, mobile phones, smart objects, and online communities, offer opportunities for unique entertainment and learning experiences (Collins et al., 2010).

When considering the IoToys, learning is expected to happen in play through physical and digital manipulation of the toys' affordances. Our study employs four IoToys: Hatchimals, CogniToys Dino, Fisher-Price's Smart Toy Bear, and Wonder Workshop's Dash Robot. The purpose of the paper is to investigate what kind of play patterns may be detected in the connected toys included in our case study. One of the main goals is to explore which educational needs these toys cater to by investigating their educational promises through three perspectives: an analysis of the toy makers' ideas on the affordances and educational value of the toys; a survey concerning parental views on the educational potential of digitally-enhanced toys; and finally, group interviews and play tests regarding preschool-aged children's own responses about possible learning experiences related to the toys.

Keywords: Media education, Internet of Toys, Toyification of education, Toy-based learning

1. Introduction

Play is the paragon of enjoyable, intrinsically motivated activity associated with a wide range of positive effects on motivation, social interaction, learning, and experiences. Toys and games are artefacts purpose-built to afford play and its positive effects (Deterding, 2016). From the viewpoint of the ludification of culture (e.g., Sutton-Smith, 1997; Raessens, 2006), we believe that parallel to developments in terms of gamification, different areas of culture, such as education, are becoming increasingly toyified as well. In this study, we are interested in "connected play" (Marsh, 2017), which emerges through interaction with toy-based learning systems, i.e. the Internet of Toys. According to Marsh, connected play manifests typically as transmedia-based and multimodal as well as potentially something that challenges and dichotomizes spaces and concepts. Connected play can be framed as a continuous flow between different domains—online and offline, digital and non-digital, material and immaterial, but also public and private, global and local (Marsh, 2017). Connected toys can also contribute to the blurring of the boundaries between formal and informal learning (Montgomery, 2015, p. 268). These playthings can give children a choice in the place and mode of their learning (Gordon, 2014, p. 3). Connected toys, or playthings understood as a part of the Internet of Toys (IoToys), present educational possibilities, particularly in informal situations; learning can happen in the home environment when children learn languages by playing with their smart toys. In this way, the IoToys offers significant educational benefits and brings with it new possibilities to existing learning technologies.

Definition of the Internet of Toys

The goal of our study is to understand one aspect of the Internet of Things (IoT), which in the context of children's everyday play often comes to mean play experiences especially related to toys connected to the Internet. In this paper, we use the concept of the IoToys (Wang et al., 2010) in reference to early education to map the potentialities these smart and connected toys hold when considering toy-based learning opportunities. The IoToys includes smart toys, which 1) are connected to online platforms through Wi-Fi and Bluetooth but can also be connected to other toys, 2) are equipped with sensors, and 3) relate one-on-one to children (Holloway & Green, 2016). Examples of the IoToys are the following: app-enabled robots like Wonder Workshop's Dash & Dot, CogniToys Dino, Ozobot 2.0, and the Robotic Sphero Ball; puzzle and building games like Osmo and Beasts of Balance; smart soft toys like the Fisher-Price Smart Toy Bear; character toys like Barbie Girls MP3 Player, Woobo, and Lingufino; and other Internet-connected toys with digital game elements, such as Tiggly World, Kiddy Quizza, Toyji, the Imagino–Matoi Digital Slow Toy, and Oniri Islands (Holloway & Green, 2016; Mascheroni & Holloway, 2017).

In this study, four IoToys were chosen based on their gender-neutrality as character types of toys and their availability on Amazon US (in August 2017): 1) CogniToy Dino, 2) Wonder Workshop's Dash Robot, 3) Fisher-Price's Smart Toy Bear, and the 4) Hatchimal (which has, e.g., the CollEGGtibles app). These toys fulfil the criteria of IoToys. They are "smart," and their connectivity usually occurs through mobile devices (smartphones and tablets). In some cases, smart toys also contain their own computers (e.g., the CogniToy Dino and Fisher-Price's Smart Toy Bear). Further, the IoToys are sometimes used with remote control systems to interact with children. IoToys often use sophisticated sensor-based technologies to collect information from children and cloud-based platforms to process this information through real-time interactions. This means that the IoToys offer new opportunities for personalized content to be used in play and learning.

The purpose of this paper is to investigate the kinds of educational promises that IoToys hold in terms of their play affordances related to their envisioned play patterns. One of the goals is to explore which educational needs (e.g., language learning) the toys included in our case study promise to fulfil. Our study includes an investigation of Hatchimals, CogniToys Dino, Fisher-Price's Smart Toy Bear, and Wonder Workshop's Dash Robot. By interviewing preschool-aged children's parents about their attitudes towards digitally enhanced toys, by analyzing the physical and digital affordances of the four aforementioned IoToys, and by playtesting the toys with preschool children in a group interview situation, we arrive at new insights regarding potential learning experiences with currently popular IoToys.

2. Related Work

The IoToys are emerging in a world of networked technologies where many choices and decisions are automated, networked, and streamlined, including learning (Marsh et al., 2017). Although there has been a lack of studies in the field, the potentiality of IoToys is seen, for example, in museum pedagogy and education (NMC Horizon Report, 2015). As the IoToys in the context of education represent a rather new area of academic inquiry, it is also conspicuous that studies that are more technology-driven outnumber studies mainly interested in the educational value of the toys. In our study, we focus on the educational promises of the IoToys, the possibilities of using smart and connected toys to offer rich, interactive, innovative, and mobile learning experiences to preschool children both in the educational environment as well as during leisure time (Pruet et al., 2015; Joyce et al., 2014) as suggested by the makers and marketers of the toys.

We have conducted a literature review related to work on children, technology, and Internet-connected toys. Previous studies of children's interaction with technology have explored, for example, how young children perceive their computer use (McKenney & Voogt, 2010), involving children in content control (Hashish et al., 2014) and reactions to health monitoring technology (Toscos et al., 2012). Technology-based toys have been reported to be increasingly popular with children (Cagiltay et al., 2014). In earlier research on smart toys, researchers identified some of the unique features that connected with different developmental stages. Hello Barbie has been complimented for its strong encryption practices, through its websites were sometimes found vulnerable (Somerset Recon, 2016). ToyTalk and Mattel's Hello Barbie was quickly met with controversy upon its release, with Twitter hashtags such as #HellNoBarbie and an outline of the downsides to a connected toy, identifying issues with privacy, by the Campaign for a Commercial Free Childhood (2015). On the other hand, both CogniToys Dino and Hello Barbie have been cited as leaders of security practices for connected toys (Dobbins, 2015; Sorcher, 2016). The findings of McReynolds et al. (2017) illuminate people's mental models and experiences with these emerging technologies, which help inform the future design of interactive, connected toys and gadgets.

3. Toyification of Education

The toyification of education means that three-dimensional and interactive toy(like) objects are becoming increasingly used in the context of pedagogics and learning. Thus, by the toyification of education, we suggest that current toy design is prominently interested in the integration of learning opportunities into toys. Thanks to developments of the IoToys, contemporary playthings demonstrate a trend that combines "toyish" design elements (forms and functions previously associated with traditional toys), connectivity to networks, and features that afford both playful enjoyment and engagement, which can be applied to educational activities in both physical and digital learning environments. By using toyification of education as a conceptual framework in understanding the emerging role of IoToys in the educational context, the authors aim to understand which kind of elements and affordances provided by the toys suggest opportunities for learning, both in terms of their physical qualities and digital dimensions.

Physical and digital affordances of the chosen IoToys

Although the world is increasingly digitalized, material and tangible playthings—and character toys in particular—continue to intrigue players of different ages. Traditionally, three-dimensional play objects may be evaluated by their physical (tactile), fictional (narrative), functional (mechanical), and affective (emotional) qualities. However, when considering technologically enhanced toys with digital connections, we must recognize both their capacity to make use of what is possible in terms of their connectivity and, additionally, their capacity to function in situations when their status as "receivers" becomes defunct.

As McReynolds et al. (2017) note, connected toys are becoming more and more commonplace. Marketing campaigns often emphasize the educational and developmental qualities of these toys (McReynolds et al., 2017). Therefore, to be smart, skilled, and connected in the twenty-first century, the playing audience must be digitally aware of the capacities of these types of toys. For digital natives, ways of acting and being in the social world are framed by their experiences with digital technologies, such as mobile technologies and connected toys. Nowadays, young children's toys contain sophisticated technologies in comparison with the traditional (in many cases non-digital) toys played with by their parents. Play experiences related to these toys change children's dispositions to learning and behaving.

We selected four contemporary toys for our study—CogniToys Dino, Wonder Workshop's Dash, Fisher-Price's Smart Bear, and Hatchimals—based on their suitability for the age-group (preschoolers, 5-6 years), availability and popularity on Amazon US in August 2017. All of the toys chosen for this study represent different character toys, meaning that they carry a resemblance to known animal (CogniToys Dino, Fisher-Price's Smart Toy Bear) or familiar robot forms (as in the case of Wonder Workshops Dash). Generally, animals and robot toys are today viewed as gender-neutral, which presented us with an interesting opportunity to find out whether or not children of different genders prefer one toy over another. To test out the educational potential of a non-educational, smart toy, we also chose to include in our study a currently popular toy: the Hatchimal. All of the IoToys used the English language and responded through light, sound and/or movement.

The reason for this selection of IoToys was also based on our interest in mapping out their various affordances and, in this way, their capacity to invite their users to different play patterns. What guided our interest, in particular, was our curiosity about the toys' educational potential—their capacity to cater to the educational needs of the school-children of the twenty-first century, helping them to become smart, skilled, and connected through toy-based learning. Another criterion for the toys was that they be not only operated through a screen but represent a multidimensional experience.

Figure 1. The IoToys chosen for this study. From left to right: Fisher-Price's Smart Bear; CogniToys Dino; Hatchimals; and Wonder Workshop's Dash. *Figure 2*. Children interacting with the newly hatched Hatchimal during our group interview and play test session.

All of the toys except the Hatchimal connect to the Internet via Wi-Fi. The connected toys employed in this study are hybrid playthings, which means that they are both physical artefacts and objects which function as portals to digital devices and socially shared content. In order to function in this new media environment, people of different ages need digital awareness, competence, and skills to participate in this digital world (Park, 2017). They must know how to use different technologies by understanding their affordances.

As illustrated by the toys employed in this research, the physical and digital play affordances are manifold (see *Figure 3*):

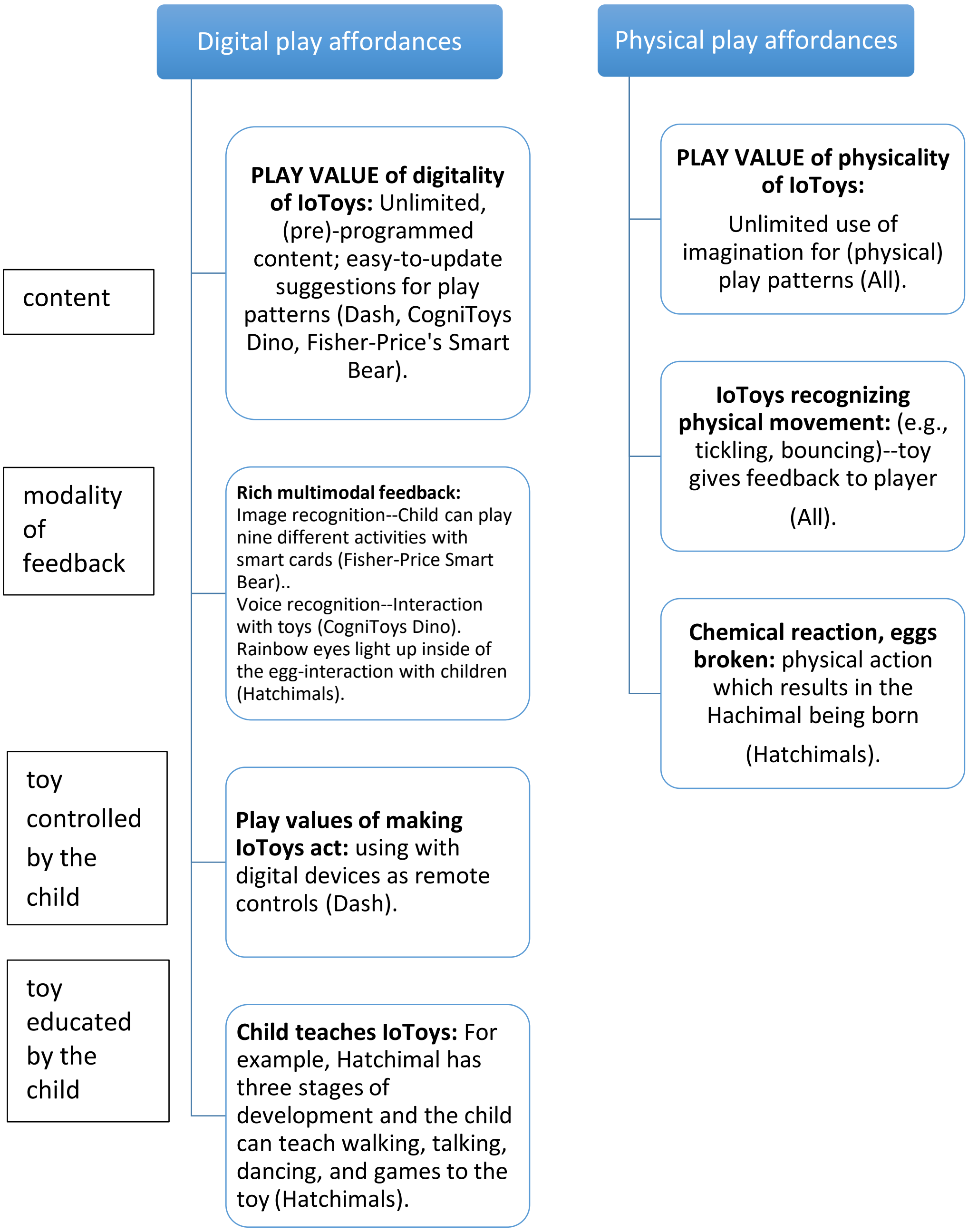

Figure 3. Digital and physical play affordances (examples) of IoToys.

Educational promises of the IoToys in our study: The marketers' perspective

Our study employs toys that, according to their marketers, cater to enjoyment and opportunities for learning. In this way, the toys under scrutiny represent "edutainment," although their educational promises are often accentuated over the play value of their traditional play patterns. Before concentrating on the educational potential of the playthings chosen for our research as reported by the preschoolers who joined in our play tests, the IoToys included in our study are briefly described in the following from the perspective of their marketers:

CogniToys Dino, a "Personalized Learning Buddy"

Amazon.com describes the CogniToys (by Elemental Path) as an educational toy that includes stories, games, jokes, and fun facts, encompassing subjects including vocabulary, math, geography, science, and more to engage "your child in educational play based on their academic needs." The age recommendation given for CogniToys by the manufacturer is five years and older. The CogniToys Dino will constantly evolve, with its cloud-connected, Wi-Fi enabled character allowing for the play experience to constantly improve and update automatically as new content becomes available. The toy is said to engage kids with a wide variety of content by encouraging learning and play using interactive dialogue. In practice, the CogniToys Dino grows with the children by listening to their questions and adapting to their personal preferences and unique educational skill set. The toy explores favorite colors, animals, and more to customize engagement as well. The educational promises of the CogniToys are that learning is a "FUNdemental Part of the CognitToys Experience" and that each Dino comes with "a variety of custom modules to engage kids in educational play including problem-solving challenges, geography games, historical fun facts and more." Once the Dino is configured using the CogniToys App, it presents age-appropriate content from the first "Hello!" (Amazon.com CogniToys Dino, 2017) CogniToys represents a new wave of toy design, having its origins in a Kickstarter campaign (Kickstarter, CogniToys: Internet-connected Smart Toys that Learn and Grow, 2017). According to a marketing text published by Toys"R"Us, the CogniToys Dino represents the "next generation of internet connected smart toys" and "can engage your child in conversations, play games, storytelling and more" (Toys"R"Us).

Wonder Workshop's Dash

The product description given by the company behind Wonder Workshop's Dash claims the toy "is a real robot that makes learning to code fun for kids."

"Responding to voice, navigating objects, dancing, and singing, Dash is the robot your child always dreamed of having. Use the free Apple, Android, and Kindle Fire apps to create new behaviors for Dash — doing more with robotics than ever before possible. Dash presents your kids with hundreds of projects, challenges, and puzzles as well as endless possibilities for freeform play. Along with Dash, you can use our five free mobile apps. The Wonder and Blockly apps are designed for every child to have fun on their own while learning how to program robots" (Wonder Workshop Dash Robot iPhone Accessories, 2017). The manufacturer recommends this toy for children ages six and up. Wonder Dash Robot has multiple apps, one of which is the Blockly App, which is in standard use in elementary schools and recommended for kids by Code.org. With Blockly, "your child or student can take on coding challenges and make their own programs for Dash. […] you can create your own dance, record your choice, and have Dash play it back, or even program Dash to follow you around. With the new tutorial section, it is possible to program with no previous experience." While the company sells its programmable robots directly to families, it has also seen Dash and Dot becoming part of schools' curricula and coding clubs over the years. According to Kolodny, some 8,500 schools are using Dash and Dot around the world today (Kolodny, 2016).

According to a marketing text published by Toys"R"Us, Wonder Workshop's Dash "is a real robot, responsive to the world, on the go and at the ready. Kids imagine the sidekick, pet, or pal they've always wanted and bring it to life with Dash and their own code. […] Dash is a faithful explorer in the world your child creates. Dash can greet kids as they come home from school, help them deliver a message to a friend, follow them on journeys, become a true partner in fun" (Toys"R"Us Wonder Workshop Dash).

Fisher-Price Smart Toy Bear

According to a product description given by Fisher-Price, the "Smart Toy is the next generation of play." Manufacturer recommends the Smart Toy for ages three to eight years. Smart Toy Bear is an interactive learning friend with all the brains of a computer, without the screen. "The more your child plays with Smart Toy, the more this remarkable furry friend adapts to create personalized adventures. Fisher-Price Smart Toy Bear can start a true friendship with a child and that will help your child grow socially and emotionally, too" (Fisher-Price Smart Toy Bear, Mattel.com). "Smart Toy is an interactive learning friend with all the brains of a computer, without the screen. When children talk, their furry friend listens and adapts to future conversations. Smart Toy actually recognizes their voice. The toy also recognizes his Smart Cards (each Smart Toy comes with nine Smart Cards and a cute little backpack to store them in). Smart Toy knows what your child wants to do: make up a story, play a game, go on an adventure and more. The Smart Toy encourages social-emotional development, imagination, and creativity" (Smart Toy Bear, Fisher-Price).

According to a marketing text published by Toys"R"Us, the Fisher-Price Smart Toy Bear's features encompass the following: "The toy includes Voice Recognition: Talks and listens and remembers what your child says—the two of them can have actual conversations! Image Recognition: Visually recognizes the nine Smart Cards included so your child can choose activities like stories, games, and adventures! Smart Card expansion packs are available "to expand the play." The toy "Learns your child's favorite things and activities! Knows when you toss him in the air (with a little help from his accelerometer). Knows the time of day, weather, and world events. Plays games with the whole family, makes up stories where your child can choose what happens next! Takes your child on imaginative adventures. Tells jokes. By downloading a free app at smarttoy.com/app, unlimited Wi-Fi content updates may be unlocked and help the Smart Toy "learn your child's name." Also, "Parents can unlock bonus activities with the app, such as bedtime, clean-up, break time, and party time!" The marketing text attached to the toy promises that "No personally identifiable data is transmitted by Smart Toy" (Toys"R"Us).

Hatchimals

A Hatchimal (by Spin Master) is "an interactive experience with a magical creature that lives inside an egg." The age recommendation for Hatchimals is five to seven years. With the help of its owner and "lots of love and care, the Hatchimal will peck its way right out of the egg and is ready to play. The egg itself is made from durable material, so the only way to get the Hatchimal out is for it to get itself out. There are two species of Hatchimals, which are birds meshed with other creatures: Pengualas and Draggles. While kids can choose the species of their Hatchimal, there still is a surprise element because they don't know what color creature is inside. Hatchimal's eyes inside the egg and the sound it makes allows kids to know how it's feeling. Dark blue eyes means it's scared, so pat the bottom of the egg or make a loud sound to make it feel better. Once it feels better, its eyes may turn pink, which is a cuddly mood. If the egg is cold, its eyes will turn light blue, and it will make shivering sounds. Cuddle it some more make it warm again. The green eyes mean that Hatchimal has become too dizzy, and kids must tilt the egg to help it sneeze or pat the bottom of the egg to help it cough and nurse it back to health. Red eyes mean that Hatchimals are angry or upset. When a Hatchimal is ready to hatch, its eyes will turn rainbow colored, and this is the sign of a party. Every egg is different, and the hatching process can take anywhere from 10 to 40 minutes. Hatchimals are babies straight from the egg." Kids will get to raise their furry Hatchimal through three stages, from baby to toddler and then kid. In toddler mode, kids can start teaching their Hatchimal things, such as how to talk (it will repeat phrases in its own voice) and how to walk. They can also dance and play music, and when kids pat its head, it will make the sound of a drum beat (Michalik, 2016).

4. Research design

The research design of our work-in-progress study consists of two initial parts: on the one hand, we have studied parents of preschool-children with a special focus on their attitudes toward and experiences of toys with digital enhancements. On the other hand, we have investigated children's own responses to digitally enhanced toys (i.e., the IoToys chosen for our study). We examine the following research questions:

RQ1 (targeting the parents): What are the parents' attitudes towards and observations of their children's play with toys with digital dimensions?

RQ2 (targeting the children, asked about each of the IoToys): What could this toy teach you and how would you play with it when a) alone with the toy and b) with other children?

We have used a semi-structured, thematic survey to explore parental attitudes and parents' experiences of connected toys. We have conducted two group interviews and interactive play tests with 20 preschool-aged children. The interviews and play tests were conducted in cooperation with two Finnish kindergarten groups and the parents of these children in October 2017.

Both empirical inquiries include questions concerning the toys' educational potential. Our methodology includes participatory observation, play tests, and written and visual types of documentation through photographing and videotaping the test groups playing, learning, and interacting with our IoToys, including the children drawing their chosen IoToys after the play tests. The multimethod approach allows us to carry out both a narrative and visual analysis of data.

Parental survey

We have used a thematic survey to explore parental attitudes and parents' experiences of connected toys. Although the 14 parents of the altogether 20 preschoolers who participated in our play tests were interviewed about a wide range of topics in relation to digitally-enhanced toys to be presented in the following stages of our research, this paper focuses on mainly on investigating the following questions:

- Does your child play with the (digitally enhanced) toy alone or in the company of other children?

- Do you think that playing with this kind of a toy teaches the child new skills?
- Does the child simultaneously use (other) mobile devices when playing with the toy?
- Does your child play with the toy in any of the following ways: nurses the toy; uses the toy in narrative play (gives the toy a role and lines of speech in play); explores the toys' mechanical features; tries to teach the toy new skills; uses the toy as a bedtime companion?

Group interviews and play tests

Moreover, we have conducted two group interviews and interactive play tests with 20 preschool-aged children (5-6 years of age) in a Finnish group and a Finnish/English speaking bilingual group in a West-coast Finnish town in October 2017. Finnish children are introduced early to mobile technologies and many even have their own mobile phones and tablets before starting school (typically at age 7). We were informed that the children in the Finnish group each have their personal tablet at preschool, which they are allowed to use in supervision for a limited time per day.

In order to understand the children's exposure to mobile technologies, we also asked their kindergarten teachers how many of them have a mobile phone of their own. Of the children that participated in our study, 10 reported owning a mobile phone of their own. This question was relevant in developing an understanding of whether or not it is possible for the children to, for example, use the mobile phone to operate an app, photograph, or video-record their toys by themselves.

5. Findings

The *educational promises* of the IoToys are many, if the toy marketers are to be believed. Technologically enhanced toys seem to cater to the need to educate children to become smart, skilled, and connected individuals of the twenty-first century and to do so in different ways. The toys included in our study, according to their marketing materials, suggested educational benefits could be gained through play, such as learning vocabulary, math, geography, science, and more to engage through learning and to play using interactive dialogue (CogniToys Dino); hundreds of projects, such as coding challenges and puzzles (Dash); social-emotional development, imagination, and creativity (Fisher-Price's Smart Toy Bear); teaching the toy things, such as how to talk (it will repeat phrases in its own voice) and how to walk (Hatchimals). It is notable, how in the case of Hatchimals—the only non-educational toy featured in our study—the role of the teacher is given to the playing child.

The envisioned play patterns of the chosen IoToys, according to the toy marketers, are the following: the making of stories, games, jokes, and fun facts; play using interactive dialogue (CogniToys Dino); and endless possibilities for freeform play. The player can, for example, create his/her own dance, record the choice, and have the toy play it back (Dash); the toy invites the player to make up stories, playing a game, go on adventures, and more. The toy listens and adapts to understand conversations, the player's voice, and the Smart Cards included in the packaging (Fisher-Price's Smart Toy Bear). The toy can dance and play music, and when kids pat its head, it will make the sound of a drum beat (Hatchimals).

The toys' capacity to invite their players to imaginative and creative play and, in this way, their potential play value in terms of open-ended play (and intrinsically motivated play), when contrasted to their educational value (instrumentally motivated play) seems in balance as all toys afford both forms of play. Next, we will turn to the results of the parental survey, illustrating parents' attitudes and observations about digitally enhanced toys on a more general level to see whether these support the marketers' educational promises being fulfilled in the toy play of their children.

Parental survey

Altogether 14 parents (n = 11 female, n = 3 male) from different socio-demographic backgrounds participated in our semi-structured survey. Ten of the parents reported that their child owned some kind of toy with digital dimensions. We asked the parents to specifically describe the toys with digital dimensions in order to understand their preconception of IoToys. According to the answers, the toys could be grouped into three categories: toy robots or other toys featuring light, sound, and movements (i.e., "robotic toys that follow orders" (Parent1FE); "a soft toy that mimics speech, singing dolls, and also has lights" (Parent5FF);"trickster car, robot" (Parent1FF); game consoles ("Nintendo Wii game console") (Parent4MF); but also mobile phones, tablets, and computers ("iPad apps, a recording microphone") (Parent7FE); "mobile phone, tablet = apps" (Parent2FF).

Only two of the parents reported that their child played with the toy alone exclusively; all other respondents said that their child played with the toy both alone and with others. Half of the parents considered their child to have learned something while playing with digitally enhanced toys. The majority of the parents (8) said that their child did not use other mobile devices while playing. Only two of them responded that their child does use other mobile devices while playing with a toy. The most popular play pattern the parents reported their children performing was to explore the toy's mechanical features (9 children of 20), and the second most popular play pattern was to use the toy in narrative play (7 children out of 20). The third most popular play pattern was to nurse the toy and use it as a bedtime companion (6 children of 20).

Considering the educational features of the digitally enhanced toys, the parents who answered these questions reported the toy's most important feature to be its ability to teach the child to how to count, to be self-expressive, to teach good manners, and to take other players into consideration. The toy's ability to teach its player to read, make questions, and be self-expressive (e.g., to come up with stories) were considered somewhat important by the parents.

Children's responses to the IoToys

In the two group interview sessions, the researchers introduced all four IoToys to the children one by one, first by showing the toy and then letting each child interact with it. Finally, we showed the children a short video of the toys' functions based on non-commercial material (review videos) found on YouTube. During the child-toy interaction, the group was asked the three following questions: 1) what the toy could teach them, 2) how the child would play with the toy alone, and 3) how the child would play with the toy in the company of other children. The children's answers from the group interviews to these questions are collected in the table below:

Questions	CogniToys Dino	Wonder Workshop's Dash	Smart Toy Bear	Hatchimals
What the toy teaches the child (educational play patterns)	* How to make different sounds * How to sing * Music	* How to make different sounds (e.g., farm animals)	* English language * Tells stories * How to play tag	* How to sing * How to fly * How to read
How the child would play with the toy alone (solitary play patterns)	* Dance * Sing with the toy * Play disco with it * Use it in play in which you need music * Use it as a lamp * Take videos with it * Nurse it	* Play tag * Play hide and seek * Play house	* Nurse the toy * Play hide and seek	* Take a walk with it *Use it as a bedtime companion * Play with it as it was a pet * Swing with it
How the child would play with the toy with other children (social play patterns)	N/A	* Play disco dancing * Play football * Make arts & crafts	* Play school with the toy * Share the toy * Play house	*Take care of it with others * Watch it play

Table 1. Educational, solitary, and social play patterns associated with the IoToys as described by the children who joined our study.

After the group interview session, the children were asked to choose one toy of the four presented and draw a picture of it. Drawings made right after the English group interview were almost equally divided between the Hatchimals (3), Smart Toy Bear (4) and Dash (4). In the Finnish group, the drawings of the nine children were dominated by Hatchimals (6), followed by Smart Toy Bear (2) and Dash (1). None of the children in the two groups decided to draw the CogniToys Dino.


Figures 4 and 5. Children drawing their chosen IoToys after the group interviews and play tests.

A limitation in the existing literature regarding education guided by the IoToys is that it does not provide a clear description of how children learn to use these toys in play. Without a basis for understanding how children learn to use IoToys in play, it is difficult for educators to observe and assess young children's technological learning. As our study shows, without guidance and structured educational goals, the IoToys are generally considered "normal" toys (i.e., toys without the use of pre-programmed content) in a play situation. Although the IoToys include educational value, in order for their educational promises to be fulfilled, educators need to guide young children's digital play in preschool learning situations. Marsh et al. (2005) suggested that educators were interested in using technologies with young children but lacked access to an appropriate pedagogical framework for understanding children's education by the IoToys. This means that descriptions of children's ideas on and play behavior with the IoToys are useful for educators because they can use these to inform the provision of technologies in early childhood settings in much the same way that, in the provision of experiences related to role playing or construction play, which again, are informed by descriptions of children's exploratory play.

Our study suggests that effective use of IoToys in early childhood learning situations could be addressed by developing new ideas about children's interaction with digitally-enhanced playthings in general: these patterns of behavior are not necessarily dictated by the digital affordances of the toys, but rather, the physical affordances of them. The character-type IoToys employed in our research show that the imaginative play patterns, such as treating the toy character as a companion that may be nurtured and played with without light, sound, or movements, often overshadow its educational potential grounded in the pre-programmed content that guides the child in learning how to carry out, for example, language-based activities. This means that recognizing children's actual play activities with the IoToys in play-based situations would provide educators with useful knowledge on the toys' capacity to invite play patterns beyond digital play. This is because early childhood education is traditionally play-based, and educators are used to observing and assessing young children's play.

6. Discussion

The purpose of this paper was to investigate what kind of educational promises may be expected from the IoToys included in our case study. One of the goals was to explore which educational needs the toys included in our study fulfil. We used four examples of IoToys with preschool-aged children in Finland: the CogniToys Dino, Wonder Workshop's Dash, Fisher-Price's Smart Toy Bear, and one non-educational toy, Hatchimals.

Some of the features of the toys explored in this paper offer, thanks to their connectedness, limitless possibilities in terms of pre-programmed content when they work effectively. The preliminary results of our investigation in the educational promises of the IoToys offer some new insights on how to use connected objects as a part of educational environments, such as kindergarten or a preschool environment. By summing up our discoveries on preschool-aged children's use of the IoToys, it can be seen that young children are enthusiastic about digital affordances accessed through physical play objects, but they undertake a range of activities with these toys that foster play, creativity, and learning—they do not turn only to the digital affordances. Surprisingly, the only non-educational toy featured in our study, the Hatchimal, was also said by the children to be able to teach something. The digital natives who chose to draw this toy after the group interview situation mentioned various things the toy could teach them, ranging from educational ("reading") to imaginative skills ("flying").

Nevertheless, the connected toys under scrutiny in our study seem to present suggestions for play beyond their digital features and connectivity. As character toys representing anthropomorphized “creatures,” the toys’ promotion of educational features, in some cases, becomes irrelevant for preschool-aged children, as illustrated in our study. As our results show, digital natives seem to associate traditional play patterns with toys such as CogniToy Dino, Wonder Workshop’s Dash, and Fisher-Price’s Smart Bear. The digital natives in our study informed us that these toys could be nursed, used to play hide-and-seek, used as bedtime companions, played house with, etc. The toys that included sound and movement inspired the children to envision play patterns such as disco dancing and playing tag. The toys that included light were observed to be useful in practical situations as well: the toy could be used as a lamp.

When considering the IoToys, learning is expected to happen in play through physical and digital manipulation of the toy’s affordances. Moreover, as we suggest, there are other dimensions to these affordances, which we believe cater to two major needs set out for toy design, namely social and pedagogical affordances. The capacity of IoToys to invite the players to social play is to be considered both part of their digital and physical affordances. Finally, their educational affordances seem to be embedded in their connectedness and digitally-enhanced features.

7. Conclusions

Whereas games (both physical and digital) have, for a long time, been considered a sufficient educational media and recent developments have demonstrated a gamification tendency in the realm of education, we believe that, paralleling this development, it is possible to see an emerging toyification of education, especially when considering the IoToys as a part of the global phenomenon of the IoT. Toy-based learning, contrary to the often structured, rule-bound, and competitive game-based learning, seems to build more on an open-ended, imaginative but still educational realm, especially fit for young learners such as children of preschool age.

The study presented in this paper is part of a larger study interested in the IoToys-related character playthings’ capacity to invite children to play. The following steps in this ongoing research project will concentrate on investigating two major areas of inquiry: first, continue the investigation and discussion of the pedagogical and social affordances of the IoToys and second, continue the research by analyzing research materials collected about general attitudes to contemporary toys and parental attitudes towards the connected toys as a part of children’s consumption of digital media content in particular. Finally, we are interested in the multidimensional techniques of how the toys persuade their players to nurture them, guide the players to social interaction with other players, and promote connectivity.

It should be noted that several limitations pertain to this study. These include the scarcity of both earlier literature and background information collected from parents in the survey as well as the setting of the study. In other words, the limitations that must be consider are a) the earlier literature on the IoToys used in education; b) the parental attitudes toward and observations of digitally-enhanced toys surveyed, which did not particularly address the IoToys under scrutiny in this paper but digitally-enhanced toys in general; and c) the study environment, which in our study was a Finnish preschool environment (for n = 20, 5–6-year-old children) in combination with our use of social group interviews and play tests rather than individual interviews. Despite these limitations, our goal in this study was to consider the potential of the use of IoToys in an early-education context as a new tool for observing and assessing young children's toy-based learning. This work has implications for the field in terms of supporting early educators in better understanding how children learn through the use of IoToys through play. As a consequence, they are able to plan more effective toy-based learning that takes into consideration contemporary toys' capacity to "teach" their players beyond their digital affordances or, rather, through their multidimensionality, providing possibilities to connect and educate children to become playfully smart, creatively skilled, and both socially and digitally connected in the twenty-first century.

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