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Preschoolers Learning with the Internet of Toys: From Toy-Based Edutainment to Transmedia Literacy

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Figure 1. The set of IoToys that was used in our study. From left to right: Fisher-Price's Smart Toy Bear, CogniToys Dino, Hatchimals and Wonder Workshop's Dash.

Abstract

The Internet of Toys (IoToys) as an emerging type of edutainment presents a new research area, especially in the context of learning. This study investigates four connected toys played with in the preschool context. By turning to preschool-aged children and their educators observed and interviewed during and after a play test and group interview session, we study how the educational value of IoToys is actualized in a play situation in an early learning environment. In order for IoToys to work as tools in toy-based learning in the preschool context, we suggest that educators acknowledge the engagement with these toys as a form of transmedia play which demands transmedia literacy skills.

Keywords: Early education, Edutainment, Internet of Toys (IoToys), Toy-based learning, Toy Literacy, Preschool-children, Transmedia Literacy

Introduction: New approaches to toy literacy

Toys, as an expressive medium, provide opportunities for both entertainment and learning. As Hassinger-Das et al. (2017) observe, any item that can be used for play may be considered a toy, including manufactured toys, as well as everyday items. Today, many types of toys seem to strive to have status as playthings that cater for needs of *edutainment*, that is, to serve as both education and entertainment.

In today's world toys are increasingly connected to technologies and digitally mediated realms. Some even consider mobile communication devices themselves as a new type of playthings, and various screens included in smartphones and tablets are functioning as toys for children (Hassinger-Das, et al., 2017, p. 2). One example of such toys are the playthings emerging in the category of the *Internet of Toys* (or IoToys). These connected toys are a subcategory of the global phenomenon of the Internet of Things (IoT).

The Internet of Things (IoT) is a concept referring to the connectivity of any device with the Internet. IoT could be considered as a giant network of connected people or things like toys, the connections is between things-things, people things or people-people (Morgan, 2014). In the current situation, smart toys have evolved into connected playthings, that according to Holloway and Green mean smart toys, which 1) are connected to online platforms through Wi-Fi and Bluetooth, but can also connect to other toys, 2) are equipped with sensors, and 3) relate one-on-one to children (Holloway & Green, 2016).

The Internet of Toys (IoToys) will allow the children of this generation to experience seamless interactive technologies geared for entertainment and education unlike any previous generations. Through connectivity, these smart, hybrid toys, most often representing anthropomorphized characters, suggest that players connect to online environments in order to get involved in digitally-enhanced and socially mediated play.

Generally, toys encourage three subtypes of play: (1) pretend play, (2) object play, and (3) physical play (Hassinger-Das et al., 2017). In a digitalizing age and especially, when considering the IoToys, which can potentially be used in all three types of play, this list needs to be extended to include the notion of *digital play*. Researchers Marsh et al. (2016) discuss digital play as follows: "Contemporary play draws on both the digital and non-digital properties of things and in doing so moves fluidly across boundaries of space and time in ways that were not possible in the pre-digital era" (Marsh et. al., 2016, p. 9). Plowman et al. (2010) describe guided interaction with information and communication technologies as interplay, which they see as children's interactions with technology that can be actively supported in preschool settings. They present the concept of guided interaction as follows: It is 1) a tool for thinking about the different modes by learning in preschool settings, and 2) that helps practitioners to articulate, reflect and legitimise changes in pedagogy. In our case study guided digital play is one of the subtypes of play, where preschool teachers have the possibility to guide digital playing with a learning purpose, for example in teaching language skills, mathematical skills and so on.

Connected toys can contribute to blurring the boundaries between formal and informal learning (Montgomery, 2015, p. 268). With these toys, children's input (data) can be analysed and responded to in increasingly individual ways. The individualisation makes the potential to offer great educational benefits and is at the centre of significant changes in existing learning technologies (Gordon, 2014, p. 3). The playful learning experience also contributes to the blurring of boundaries between formal and informal learning. This is where principles and elements of Internet of Toys' design that entertains and engages children are utilised as pathways to their learning. Nevertheless, due to the complex nature of the IoToys as entities that according to their marketers cater for learning opportunities for children and furthermore, offer fun and entertainment for

young children, we believe that a critical inspection of these playthings' actual capabilities to carry out this dual goal is needed. One way to start this investigation is to steer the focus into questions regarding media literacy, in other words, our ability to understand and evaluate media - in our study the hybrid medium of the connected toy.

Media literacy arises from the interface and interaction between media and user (Park, 2017). Our digital technologies have changed rapidly over the last decade which is related to a developed view on literacy as proposed in the literature. For example, ICT literacy, information technology literacy, media literacy, online literacy, multimedia literacy and new literacies (for reviews, see Markauskaite, 2006). Digital literacy means the functional skills required to operate and communicate with technology and media. It also refers to the knowledge of how technologies and media affect the world. Lankshear and Knobel (2003) describe new literacies as a new type of knowledge associated with a "digitally saturated social practices". Martin (2008) describes digital literacy in the following way: It is

> *"the awareness, attitude to ability of individuals to appropriately use digital tools and facilities to identify, access and synthesis from digital resources".*

Again, toy literacy (Sutton-Smith, 1986) of the contemporary kind needs to be assessed from the viewpoints of both digital play and digital literacy. Yet, with the IoToys in mind, the concept of digital literacy alone is not sufficient in explaining the wide spectrum of skills that are demanded in understanding and using the connected toys. As stated by Mäyrä, ludic literacy includes understandings of (a) technology, (b) culture, and (c) social dimensions of games and play – capabilities to step within a game, interplay with others, and be creative within those frames (Mäyrä, 2016). Moreover, the use of toys and games calls out for ludic literacy skills. In fact, what is required, is to view the emerging connected playthings as a transmedia phenomenon. According to Alper and Herr-Stephenson (2013), "Transmedia experiences invite children to draw upon multiple literacies, including digital, textual, visual, and media literacies, as well as social skills and cultural competencies". As educators look ever more to new media as a site for meaningful opportunities for children, transmedia can be a resource for learning in various contexts, they claim (Alper & Herr-Stephenson, 2013). With these developed understandings of media literacies in mind, it becomes apparent that in order to be able to fully grasp the various dimensions of this new category of playthings, multiple literacies must enter the discussion. Furthermore, in order to understand the capacity of the Internet of Toys from the perspective of early education, both parents and educators need to become familiarized with the notions of *transmedia literacy*.

Figure 1. *21st century toy literacy*: The evolution of required literacies.

Positioning Playful Learning within the IoToys Phenomenon

One critical pathway to exploring the possibilities the Internet of Toys holds is to investigate them through the concept and activity of play. We know already that play is an essential activity to improve and develop children physically, mentally, emotionally and socially. Playing is a natural way to solve problems and understand the environment. Play also teaches a child to react and handle circumstances around enjoyable activities. Play has its value as a mean in

children's learning. As Rapeepisarn argues, play prepares children for informal learning as they begin their school years and each step along the way (Rapeepisarn et al., 2006).

However, 'play' means different things to different people: "Across early childhood education and home environments, play has shifted from its previous child-initiated basis of "free" or "unstructured play" to a structured, educational thrust for early academic preparation", Fisher et al. state (2008, p. 305). The reason is that play is viewed as having a value and a valuable place within the school curriculum (Zoney, 2005). The teacher has an important role in helping children learn through play by selecting material they know, and guiding them when they need help. When children are free to follow their interest and organize their own experiences, learning happens naturally (Dodge & Bickart, 1998).

As Hirsh-Pasek et al. (2009) describe, both free play and playful learning should command a central role in high-quality education for preschoolers (Hirsh-Pasek et al., 2009, p. 54). Nicolopoulou (2010) has recognized three main reasons for this. First, one impetus for the growing academization of preschool is the recognition that young preschool children's acquisition of literacy is critical of their long-term learning and school success. Play-based practices that engage children's interest and initiative (along with narrative practices like interactive book reading) fit children more effectively than top-down didactic transmission. Secondly, forms of social competence are also crucial elements of school readiness, because they help promote children's cognitive achievements as well. Key dimensions include self-regulation of behavior, attention and emotion, the capacity and willingness for cooperation and social understanding. Various forms of play have a critical role in promoting these socioemotional skills during children's early years. Thirdly, children need a certain amount of self-directed free play – including physical play.

Kangas (2010) sees playful learning as a key competence in teaching and learning. Playfulness refers to the learning actions and their qualities (e.g. Bodrova & Leang, 2003). It is also seen as an attitude towards learning and a way of learning through play and games with *playful learning environment* (PLE) settings. The literature related to playfulness assumes it to have positive effects on learning at various school levels and on learning in working life as well (e.g. Sawyer, 2006). Kangas (2010) has described creative and playful learning in Playful Learning Environment settings as 1) learning that allows, stimulates and promotes learner creativity and knowledge co-creation, 2) learning through designing content for the PLE by using new technology, and 3) learning through a variety of playful and physical activities, which take place in the PLE. Kangas defines the goal of playful learning as follows: It is curriculum-based learning that is enriched with play, games and technological affordances. Once toys are used, and ludic behavior becomes *object play*, motivations, goals and outcomes of learning are easier for researchers to observe.

Play has value for education, and some toys are considered to have play value. Play value is a term used to describe the overall enjoyment of a child with a certain toy (in this case, IoToys). Toy design educator Gielen (2009) explains: "A toy is a tool for play, and it must be useful tool." Various factors contributing to play values which give indications of qualities and weaknesses in the design of the toy. The term often used to label the worth of play is 'fun', which means that fun is rather an effect of the activity than an activity itself. Play value is what motivates children to start playing, to continue and elaborate the play activity, and what makes them feel satisfied when they stop and what makes them return to the activity. Many toys may be much more valuable if they are directed to children with a certain set of preferences, interests, knowledge, skills or character.

Unstructured play that requires imaginative or creative processes, often lacks clearly delineated rules or goals (Fisher et al., 2008, p. 309). Fisher et al. (2008) have noted in their research how a mother who believes that structured activities set the best foundation for future academic learning is more likely to create an environment that promotes learning through structured toys and activities (Fisher et al., 2008, p. 313). In the context of the IoToys, as hybrid entities blurring the boundaries between the physical, digital and the connected play objects which we believe will become a normalized part of toy culture in the future, these structured toys and activities come to present issues related to literacy that are more complex and novel in comparison to for example traditional, physical and non-connected toys.

The nature of contemporary toy play is not only present in play patterns regarding the material dimensions of play, but also in its increasingly *hybrid* and *social* in nature (Heljakka, 2016). Furthermore, it has an increasingly transmedia quality. The concept of transmedia describes the complex relationships between media audiences, producers, and content (Alper & Herr-Stephenson, 2013). Again, transmedia literacy entails that learners derive meaning from the paths they make for consuming, creating, and sharing media elements. One way to understand the emerging field of IoToys and the play that happens with them, is to widen the aforementioned concepts of toy literacy, media literacy, digital literacy and finally, ludic literacy to the notions of *transmedia literacy* and understandings of play to the notion of *transmedia play*. *Transmedia play* refers to a "new way to understand how children develop new media literacies through their interactions with contemporary media that links stories and structures across platforms" (Alper & Herr-Stephenson, 2013). Learners not only construct their own meanings from transmedia messages, but also derive meaning from the paths they make for consuming, creating, and sharing media elements. Transmedia play is characterized by the following five facets, which makes it valuable for learning: *resourcefulness, sociality, mobility, accessibility,* and *replayability* (Alper & Herr-Stephenson, 2013). According to the researchers, the concept applies to media that has no storyline; for example, crossword puzzles or open-ended videogames (Ibid.). We suggest that the IoToys investigated in this paper demonstrate not only structured but also open-ended potentialities for play, and the play that happens with these connected objects may best be understood from the perspective of transmedia play.

Related Work

The first 'smart toys' were developed over a hundred years ago, as Thomas Edison adopted his wax-cylinder phonograph to create the first popular "talking toys". Until 1998, these mechanical inventions were limited to only a handful of phrases. During the late 1990s the world was introduced to Furby, a new kind of 'smart toy'. Suddenly, writes Pesce, "the toy talking to a child has its own language (Furbish), has the ability to compose simple sentences, and responds to a number of verbal and physical commands". Toys constant interactions with people make them more communicative, and one toy can share its learning with another (Pesce, 2000, p. 5).

In a research paper from the last decade it was claimed that top selling toys and electronic media of the contemporary kind are marketed as having educational benefits (Fisher et al., 2008, p. 307). "Such toys have highly visible value since they clearly promote academic learning (e.g., teach ABC's and numbers) and engage children (e.g. through flashing lights and interactive buttons)". In today's world, contemporary 'smart toys' are not only enhanced with

technologies to facilitate learning through educational affordances and audiovisual features, but also through their connectivity to online platforms and access to content mediated through these realms.

In this article, we use the concept of the Io Toys (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. These kind of play resources can be characterized as objects in which the digital and physical are linked and which thus facilitate connected play (Chaudron et al., 2017; Wang et al., 2010). Furthermore, the term is related to the concept of a network of physical devices that are digitally enabled and allow collection of data (Kopetz, 2011). However, this category of physical play objects that are digitally connected open new possibilities for the toys to become connected via the Internet with other toys and other players. The Internet of Toys' development and related research has just begun.

In our research, we have reviewed related work on children and technology and Internet-connected toys. This category of toys represents quite a new phenomenon in the academic field and the studies of IoToys are still scarce especially regarding toy research and studies on toys as a cultural phenomenon. For the most part, previous studies are focused on technological matters, which present a relevant area of academic inquiry, but not the only one. Studies have, for example, explored how young children perceive their computer use (McKenney and Voogt, 2010), involving children in content control (Hashish et al., 2014), and reactions to health monitoring technology (Toscos et al., 2012).

One example of a popular plaything representing the IoToys is ToyTalk and Mattel's Hello Barbie. The toy 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 (Campaign for a Commercial Free Childhood, 2015). Hello Barbie has been complimented for its strong encryption practices, through its websites were sometime found vulnerable (Somerset Recon, 2016). In other words, IoToys toys should ensure children's safety as well as provide appropriate content for them.

In the study at hand, we are more interested in the IoToys' possibilities to be used in the context of learning. Consequently, we bring into discussion the topic of toy-based learning, which we see to have a similar purpose to support effective learning as playful learning has. Educational value is frequently used as a marketing tool for smart toys with claims about accelerating progress in learning to read, write and use numbers. However, learning toys are often based on mundane educational tasks disguised as entertainment. The interactivity of smart toys may well provide educational and play value for the preschool context as school environments, but digital interactivity alone does not guarantee either an educational or a playful encounter. One of our goals is to turn the focus to the preschoolers themselves in order to find out about the toys qualities encouraging transmedia play.

Our Study: Preschoolers playing with the Internet of Toys

The possibilities of using smart and connected toys in education seem to offer rich, interactive, innovative and mobile learning experiences in preschool children as well as in leisure time as suggested by the makers and marketers of the toys (Pruet et al., 2015, Joyce et al., 2014). In earlier stages on our research (Ihamäki & Heljakka, 2018) we have explored the educational potentiality of the IoToys. The goal of this study is to understand the IoToys in terms of their suitability to be used in toy-based learning and their relationship to transmedia play.

By investigating the toys' possibilities to be used as tools in toy-based learning, agency needs to be given to the main audience for the IoToys, i.e. the preschool aged children. In Finland this means the context of primary education for children who are typically 6 years old, who we in this paper consider to represent *digital natives*. Prensky (2001) described digital natives as people who lives their lives immersed in digital technologies and they learn differently from previous generations of people. They have grown up in a digital environment where immersion in digitally-related activities is part of their everyday lives. Studies suggest that the used technologies in early childhood education could be addressed by developing new ideas about children's digital play that helps educators to recognize children's activity with technologies in a play-based way (Edwards, 2013, Yelland, 2011). This is because early childhood education is traditionally play-based, and educators are used to observing and assessing young children's play. Digital play has become part of everyday life. On the other hand, the enjoyment of digital experiences through shared social interaction is possible with the new IoToys.

In their study, Fisher et al. (2008) noted that when preschoolers are offered a toy to play with that has an ambiguous causal mechanism, the first thing they do, without being told, is figure out how the toy works through exploratory play (Fisher et al., 2008, 305). Our study is interested in the IoToys-related character playthings' capacity to invite children to playful learning through the framework of exploratory play, which we understand as sensory-based play guided by curiosity.

The four connected toys employed in our study represent 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. The article at hand investigates and discusses the pedagogical affordances of the IoToys and explores, how understanding of the toys' affordances demands expanded understandings of both literacy and knowledge of the nature of transmedia play in both informal and formal settings for play – and from both educators and parents.

Method

In our study, we focus on the educational value of IoToys by investigating their educational potential through three perspectives: First, an analysis of the toy makers' ideas on the affordances and educational value of the toys; Second, a survey concerning parental and kindergarten teachers' views on the educational potential of digitally-enhanced toys in general, and finally; Third: group interviews and play tests regarding preschool-aged children's responses to a set of IoToys.

The 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. Moreover, the IoToys may be framed as—besides connected, digital toys—as transmedia playthings, which encourage their players to resourcefulness, sociality, mobility, accessibility, and replayability (Alper & Herr-Stephenson, 2013).

In the study, four IoToys were chosen based on their age-appropriateness, 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.

We examine the following research questions:

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

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

We have used a semi-structured, thematic survey to explore parental and kindergarten teachers' 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. Our methods include participatory observation, play tests, and written and visual types of documentation through photographing and videotaping the test groups playing, learning, and interacting with the IoToys, including the children drawing their chosen IoToys after the play tests.

Survey for parents and kindergarten teachers

"While parental beliefs appear to play a significant role in children's development, play-learning beliefs remain relatively unexplored in the developmental literature", Fisher et al. write (2008, p. 307). In other words, little is known about parents' beliefs about play.

We have used a thematic survey to explore parental and kindergarten teachers' attitudes and parents' experiences of digitally enhanced toys in general. 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 article 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

Skolnick Weisberg et al. (2016) suggest that adults could ask open-ended questions while children are playing. We followed this idea in our study. We

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 primary 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. 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.

Analysis

This study followed an abductive analysis, which meant that the researchers moved between an inductive reasoning and theoretical knowledge to theorize the phenomenon under investigation (Dey, 2003). Comparisons were made between theory and research materials, and within the collected, tripartite data. 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).

Results

Toy-based learning, contrary to the often structured, rule-bound, and competitive game-based learning, seems to build on an open-ended, imaginative but still educational realm, especially fit for young learners such as children of preschool age. As noted earlier, this form of play may also be understood as transmedia play.

In our study the parents and educators were not asked to specify the new skills that children learn. However, Plowman et al. (2010) found out that digital devices like smart toys, tablets, and smart phones are used to promote three

main areas of learning. The extension of knowledge about the world (cognitive objects), the acquisition of functional skills (such as the operation of a smart phone pen), as well as the development of the propensity for learning (by strengthening a range of emotional, social and cognitive functions of learning).

Based on our findings, IoToys capability to function as tools for toy-based learning requires planning and supervision from preschool teachers. While the toys offer plenty of entertainment and in this way resources for imaginative play (and thus, learning based on informal and creative play scenarios) learning with them might differ from educational goals set by preschool curricula. For example, the children often responded that a toy could teach them imaginative skills instead of cognitive ones.

According to Hassinger-Das et al., the operative word for defining pretend play is imagining (2017, p. 2). The IoToys 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.

Potentially, children play with their IoToys and build an imagined world with them. In this theoretical frame, a socio-constructivist view is adopted, according to which learning is not an individual, but particularly social and societal activity that means that learning always takes place in a social context. Under such a framework of toy-based learning the use of the educational features of the Internet of Toys contributes to the realization of: 1) Meaningful learning, based on preschool age children's own group work with educational materials (in our case for drawing a picture of their chosen IoToys plaything); 2) Authentic learning using learning resources of real-life or simulations of the everyday phenomena (in our case study the Fisher-Price Smart Toy Bear has for example smart cards that remind the player to “brush his/her teeth”); 3) Social learning: technology supports the process of joint knowledge development, connected with toys, IoToys can support collaboration between fellow preschool-aged children, who can be based at different schools or abroad; 4) Active-reflective learning: preschool-age children's playing may result in problem-solving using available resources selectively according to their interest, search and learning strategies; 5) Problem-based learning: a method that challenges preschool-aged children to “learning by doing”, preschools-aged children’s group are seeking solutions to real world problems, which are based on a toy-based learning framework used to engage children's curiosity and initiate motivation to learning.

Survey for parents and kindergarten teachers

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.

The preschool educators' (n=2) perspective in this study allowed us to consider the differences formal and informal learning environments may provide to the connected toys usage as play objects. A comment made by one of the preschool teachers accentuated the concern of educators concerning the uncertainties the digitally-enhanced toys hold for the preschool context for which these toys do not yet present typical tools used in pedagogy: "I see that digital toys are more suitable in the domestic environment than in the kindergarten" (Preschool educator, 29 years in the profession). As long as these toys are not included in curricula, educators may not know how to relate to them as playthings that also could be used in teaching. However, we see the potential of IoToys to enter this realm in the near future and claim that educators should prepare for this development.

Children's responses to the IoToys

Children's input (data) can be analyses and responded to in increasingly individualized ways. This individualization, therefore, has the potential to offer significant educational benefits and is at the center of major changes in existing learning technologies. These technologies can give children "choice in the pace, place and mode of their learning" (Gordon, 2014, p. 3). For example, acting on a toy to discover how it works thus leads to better learning compared to playing with a toy merely to confirm what has been shown (Skolnick Weisberg, et al., 2016). Bergen (2004) describes a study, in which boys and girls ages between 3 to 5 years played with 'talking' (computer-chip enhanced smart toy) and 'non-talking' Rescue Heroes figures (firemen, police officers). After an initial exploratory period, most of the children used the smart toys in similar ways. The children with speech-enabled toys (smart toy) repeated some phrases and sounds that the smart toy made and initially activated the sound/talk mechanisms, but in their free play most of them used actions and language narratives similar to those of the children with the non-talking toys. Our findings point to similar directions.

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. Our play tests took 15 to 20 minutes per smart toy. Finally, we showed the children a short video of the toys' functions based on non-commercial material (e.g. how-to-play videos) found on YouTube. During the child-toy interaction, the group was asked what the toy could teach them and how they would play with it. The answers to these questions were collected to Table 1. below:

Table 1. Playful learning patterns associated with the IoToys as described by the children who joined our study.

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

One significant result of our analysis interested in the toys' affordances was to note the role of sound and movement, which sparked ideas in children about learning of languages, making of sounds, producing music and about learning how to read. Again, the movement of an IoToy encouraged the children to envision playing a physically mobile game, such as playing tag.

The preschoolers demonstrated the playing of tag by letting the IoToys that moved lead the way and simulated catching them. The children also demonstrated making of sounds and singing during the play tests. Some children mentioned that the toy could teach them to fly, but due to the brief play test episodes this 'skill' like teaching of how to read were not discussed further on with the children. Then again, the children who participated in our study were innovative in their ways to consider what constitutes a learning experience. According to our study they do not necessarily differentiate between teaching of 'imaginative' skills (fantasy play) and cognitive skills, but rather, have a more playful perspective on the toys and their capacity to teach them.

Discussion

When considering the development of educational toys in today's world, it becomes necessary to widen understandings of toy literacy into multiple directions. Our research demonstrates, how contemporary toy literacy, especially with the emerging phenomenon of IoToys in mind, should be viewed from a multi-literacy perspective: from the perspectives of media literacy, digital literacy, ludic literacy and finally, transmedia literacy. Moreover, in order to understand the IoToys capacity as tools for learning, the concept of transmedia play, as formulated by Alper and Herr-Stephenson (2013), could be included in future research on play with these smart toys, in particular, when they are used in a formal educational setting, such as the early education context of preschools.

IoToys need to be considered from the viewpoint of *media literacy* as toys are a medium among another media. IoToys need to be considered from the viewpoint of *digital literacy* because they both provide digital content, mediate social interaction and facilitate social practices through digital technology. Moreover, IoToys need to be considered from the viewpoint of *ludic literacy*, because of their nature as interactive playable entities, i.e. their call for digital interplay with technology, other players and potentially, other cultures of play. Finally, IoToys need to be considered from the viewpoint of *transmedia literacy*, because of the play that happens with them is *transmedia play*, i.e. play that promotes resourcefulness, sociality, mobility, accessibility and replayability.

According to a developed understanding of IoToys, these playthings should be considered to afford play patterns in relation to interaction communicated through e.g. sound, lights, spoken language and movement, which invite the players to resourcefulness, sociality, mobility, accessibility and replayability. In the table below, we have identified different patterns of transmedia play informed by the educational values as communicated by the makers and marketers of the IoToys and our analysis of the play patterns communicated by the preschoolers in our study.

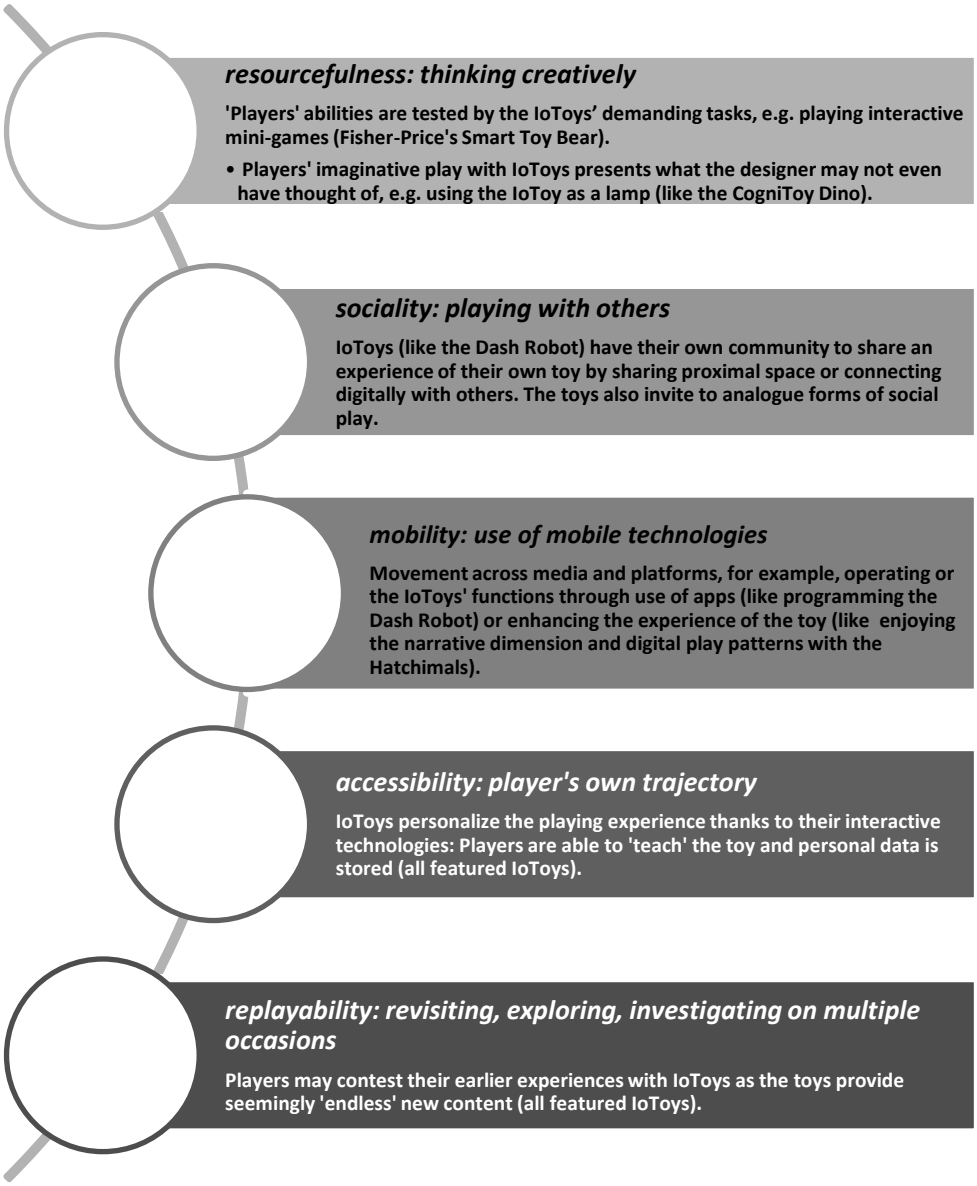

Table 2. Playing with IoToys with preschoolers: Our findings (examples) on transmedia-related play patterns as presented by Alper & Herr-Stephenson (2013).

When considering the IoToys, learning is awaited to happen in play – through physical and digital manipulation of the toys affordances. 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. With the use of IoToys, playful learning

experiences also contribute to the blurring of boundaries between formal and informal learning. Digital play may provide opportunities for edutainment - entertainment, fun and learning – both at home as well as in learning environments, but the experiences of it are dependent on a child's individual motives, adult or peer support. Nevertheless, the connected toys under scrutiny in our study seem to present suggestions for play beyond their digital features and connectivity. Finally, their pre-programmed, educational affordances seem to be embedded in their connectedness and digitally-enhanced features, although learning experiences may result from their hybrid nature, which combine the physical with the digital.

Conclusions

The purpose of this article was to investigate IoToys from the perspective of toy-based learning. 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 the toys explored in this paper, offer thanks to their connectedness limitless possibilities in terms of pre-programmed content when they work effortlessly. The results of our investigation in the educational promises of the IoToys offers some new insights in how to use connected objects as a part of educational environments, such as the kindergarten as 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 – not only by turning 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 as well. The digital natives who choose 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').

In their study, Wooldridge and Shapka found that during object play with electronic toys mothers talked less with children and were less responsive. Instead, the mothers let the toy do the majority of the work to support the interaction (for reference, see Hassinger-Das, et al., 2017, p. 4). We believe that the current situation with IoToys used both in informal and formal learning contexts is the same: Productive interaction—for example learning outcomes—are awaited to happen in the dialogues between the child and the toy. However, as our study shows, without guidance and structured educational goals given by parents or teachers, the IoToys are more considered as "normal" toys (i.e. without use of pre-programmed content) in a play situation with the exception of increased play affordances relying on sound, light, language, and movement.

Guided play can be used for teaching preschool children. It may enhance the discovery of undemonstrated functions, whereas direct instruction may inhibit this kind of exploration (Skolnick Weisberg et al., 2016). 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 smart toys. 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 in the same way

that the provision of experiences such as role or construction play is informed by descriptions of children's exploratory play.

Finally, it should be noted that several limitations pertain to this study. These include the scarcity of both earlier literature, limitations regarding the background information collected from parents in the survey and the setting of the study. In other words, the limitations that must be consider is a) the earlier literature on the IoToys used in education b) the parental and kindergarten teachers' attitudes of digitally-enhanced toys surveyed, which did not particularly address the IoToys under scrutiny 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 social group interview and play tests, not individual interviews. Despite these limitations, our goal in this study was to consider the potential of the use IoToys in an early-education context to operate as a new tool for observing and assessing young children's toy-based learning. Furthermore, we found out how acknowledging the play with IoToys as a form of transmedia play may help parents and preschool educators to assess their potential.

This work has implications for the field in terms of supporting early educators to better understand how children are learning through the use of IoToys through play, and as consequence to plan for more effective toy-based learning that takes into consideration contemporary toys' capacity to 'teach' their players beyond their digital affordances and rather, through their multidimensionality. Finally, based on our study, it is possible to argue, that play with digitally-enhanced, smart toys which we in this paper consider as IoToys, can also lead to imaginative and creative play. Seen in this light, these hybrid objects of play call out for multi-literacy and in particular *transmedia literacy*. This playful approach to literacy, when considering use of IoToys in an educational context, also needs to be understood as *transmedia play* – the simultaneous knowledge of content and characters that travel across media and between physical and digital affordances, and the contexts of informal and formal learning.

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