Still Looking for New Ways to Play and Learn… Expert Perspectives and Expectations for Interactive Toys

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Abstract

The use of interactive, smart and connected toys is expected to increase rapidly with many claiming not only new ways to play, but also to have educational benefits. However, there is a lack of evidence to support such claims and the purpose of the current analysis was to gather expert opinion about interactive toys for play and learning. In-depth interviews with 15 experts from technology corporates, stakeholder organizations and academia using a semi-structured interview protocol were conducted. The audio transcripts were coded using a Template Analysis approach with the key themes being educational utility, learning, play, and children with disabilities. The text visualization revealed that experts perceived high educational effectiveness of interactive toys. Apart from the educational value, experts also spoke about the benefits of interactive toys in entertaining the children of busy parents, privacy, security and integrative features of smart toys. This study demonstrates that for experts' interactive toys have higher perceived educational value than traditional toys or other forms of play although this is an intuition or an insight rather than based on direct evidence to support this view. From the analysis and interpretation, we identified three main recommendations 1) the need for interactive toys to provide a safe, secure and private way to play and learn; 2) increased research, experimentation and investigation to explore interactive toy claims and potential; and 3) increased interdisciplinary and intersectoral collaboration and innovation.

Keywords: Smart Toys; Interactive Toys; Connected Toys; Educational Utility; Expert Opinion

1. Introduction

Significant advances have brought technology into home, school and work, with all ages typically interacting with several devices every day. With technology continually advancing and changing, this paper considers devices designed for younger members of the family - interactive toys. In seeking to gain a current and future view of children's interactive play with technology-based toys and what those future toys might be like this research focused on the question: "*how have and are technology advances impacting on interactive toys now and in the next 5 years?*" To understand state-of-the-art rather than engaging with the intended users, such as children and parents, instead this research consulted experts with expertise in fields such as child computer interaction, content creation for children and the toy sector. This approach was based on the perspective that such experts are the most likely to have had experiences and awareness that could provide insights into current and likely near future developments for interactive toys and play.

Play is undoubtedly beneficial and critical to neurological and physical development (Goldstein 2012) contributing to the development of motor, cognitive, social and emotional skills (Guyton 2011;Healey, Mendelsohn, & Council on Early Childhood 2019; Weisberg, Hirsh-Pasek & Golinkoff 2013). Piaget proposed that children actively construct knowledge as they manipulate and explore their world, engaging in different kinds of play throughout their lives supporting the achievement of various developmental and cognitive milestones (Berk & Meyers, 2013). Play is thus essential in the formative years of life and by engaging in play, children can learn effective physical, social, imagination, creativity and problem-solving skills. According to Feher et al., (2020), there are four defining features of play. Firstly, play must involve positive affect and be fun. Secondly, play is non-literal. Hence, themes and scenarios that occur in play are separate from what occurs in the real world. Thirdly, play is intrinsically motivating and lastly, play is flexible.

Within these play dimensions, toys have an important role in triggering our imagination and motivation; laying the foundation for improving cognitive and motor skills; teaching us the importance of sharing, cooperating and communicating; and constantly evolving, reflecting our culture and our lifestyles (TIE 2021). Today's children play with interactive toys that incorporate technology to provide play. Interactive toys range from those with built- in routines to those that are smart demonstrating knowledge and skills to those that connect to the internet to support play. Unlike many other toys, as well as providing play the majority of interactive toys claim to have educational impact. This has ever been the approach with the earliest interactive toys being launched with the claim of the potential to teach (or help children learn). Already by 2001, Levin and Rosenquest (Levin & Rosenquest, 2001) raised concerns that such educational claims were unsubstantiated with interactive toys being "*marketed in ways that exploit adults' desire to choose toys that will enhance their children's learning.*" This approach and message has been wholly effective with interactive toys now somehow viewed as almost inherently educational, although educational claims for interactive toys are still not based on scientific evidence (Healey, Mendelsohn, & Childhood, 2019).

Interactive toys, or rather the marketing message to sell them are meeting a clear need, parents want value and part of that value is for the interactive toy to enable children to get more from play than fun (Richards et al., 2020). Interactive toys that claim to enhance solo play, to provide a learning experience as well as play helps to mollify parents' worries that they are not playing. However, it is challenging to understand, observe, discuss and analyse children's play interactions or to determine how this contributes to learning in the home context particularly with pre-school and early years (Kalas, 2012). Even with articulate older children it can be difficult for adults to understand or assess their play experiences.

As an alternative to engaging with children or their parents, the purpose of this paper is to report a qualitative study that gained insights and provided recommendations in relation to play, learning and interactive toys. As

discussed in this paper, this was achieved through exploring experts' experiences, expectations and perspectives of interactive toys now and in the near future and analysing this to provide a basis for recommendations for future investigation, research and development for play and learning with interactive toys. An expert is commonly defined as someone with comprehensive and authoritative knowledge in a particular area not possessed by most people. (Caley et al., 2014). Eliciting expert knowledge although difficult (Kidd, 1987), is a proven empirical technique exploited in a wide range of applications and disciplines. Hoffman et al. (2002) surveyed definitions of 'experts' proposing a return to craft guilds terminology presenting a taxonomy with seven respective categories, where expert is someone who has special skills or knowledge derived from extensive experience. Based on this approach, in this research, the following attributes were used to define the participating experts: Experts are highly regarded by their peer group and are referred to using distinguishing terminology such as 'leader', 'expert', 'best' or 'strongest'; their practitioner experience is in excess of ten years; and each has a proven track record of dealing effectively with 'tough' examples. For this study, expertise was drawn from technology corporates, stakeholder organisations and academia, with the goal of gaining insights from their perspectives on how interactive toys might advance based on awareness of current and emerging technologies.

There is the sense that there are many interactive toys, and that just as adults are now living a more digital, connected and technological life, so too are children. The research questions that this study sought to answer are exploratory, they aim to gain insights from experts about interactive toys and how they are used for play and learning in the home now and how they are anticipated to be used in the near future. To underpin and inform our expert interviews we performed a Rapid Evidence Assessment (REA) also known as a 'rapid review.' Use of this approach is increasing, driven primarily by the need to provide policy makers, service planners and purchasers, professionals and consumers with timely rigorous reviews of the literature in order to make evidence-based recommendations activities and decisions (Varker et al., 2015). This approach is particularly pertinent for technology-driven sectors and products where there can be rapid and significant change in technology, policy and regulation.

The REA of interactive toys reviewed research, technical and grey (policy and stakeholder) literature using a structured and rigorous search, providing a quality assessment of the uncovered evidence as outlined in section 2. From the REA we identified and developed a series of themes and gaps for further exploration to create a semi-structured interview with experts as outlined in section 3. Section 4 presents the analysis approach and main results. Section 5 discusses the results and their implications, providing a series of recommendations and directions.

2. Interactive Toys – Current Context

For children, playing with toys is a natural part of their everyday life. Toys are tangible artefacts purpose-built to afford play and its positive effects, objects with which the child can physically interact. It is this physicality, the embodiment of the toy which is central to its role in play. Most toys are specific in their purpose, a plush toy is to love and cuddle, a doll may talk or a robot may perform tasks, however, the functionality is bound by the intended play. Toys are defined as those artefacts "*designed or intended (whether or not exclusively) for use in play by children under 14 years old*" (Toys (Safety) Regulations, 2011) placing toys within a specific regulatory context. The Information Commissioner's Office has extended this for connected toys: "*physical products which are supported by functionality provided through an internet connection*" (Information Commissioner's Office, Sep 2020) requiring adherence to the same legislation as for other connected devices. Yet, although for many children, play often involves a tablet or phone, these devices are not classified, legislated nor regulated as toys. The same can be seen for games, in the UK, for example, rather than video games for

children falling under the toy regulation, instead it is mandatory for games to be rated by the Games Rating Authority which is part of the Video Standards Council (VSC Rating Board 2021) using the Pan-European Game Information system (PEGI 2021).

Toys incorporating technology range from those with simple built-in routines, to smart toys and those connected to the internet, as summarised in figure 1. However, the boundaries between what is an interactive toy and whether it is connected to the internet or is smart are ever more blurred. The space technology inhabits in the toy sector is still in a state of liminality, and the ways in which it is and can be used for play are in flux. Liminality, according to Firchow et al., (2017), is a series of actions to achieve the reconstruction of identity in such a way that the new identity is meaningful for society. It can be used to classify people, occupations, hierarchical roles, organizations, and events and spaces (Beech 2011). With the recent introduction of digital technologies into toy sector, a negotiation and construction of the space these technologies hold is still in question.

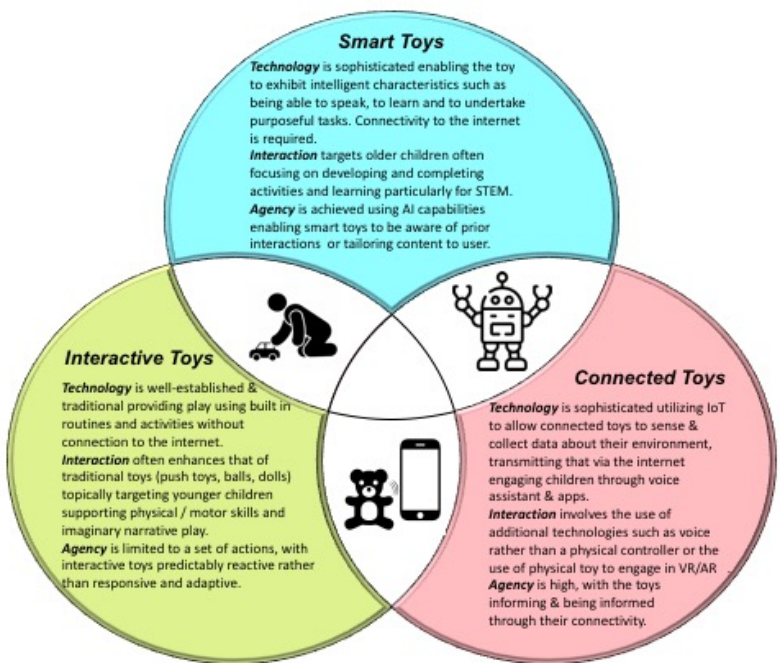

Fig 1. Differences & similarities between ‘interactive', 'connected' and ‘smart' toys

Fig 1 classifies interactive toys in terms of 1) their technology considering their level of sophistication and complexity of the technology supporting interactivity; 2) toy agency, or the degree to which the toy appears to be proactive or autonomous; and through both of these, 3) the interactions being offered by the toy. So, what does it mean to be interactive? To interact, one thing must act on another and there must be a return action. Most play activities with toys require some form of interaction, however, where an interactive toy differs from a regular toy is in that it directly and purposefully interacts back. An interactive toy will respond to a direct action the player makes on it. For example, an interactive teddy bear would laugh, giggle or tell a story when the user tickles or squeezes it. More complex interaction has been developed with toys that are smart (Prist 2019; Catala et al., 2020; Laughlin 2021), incorporating tangible objects and electronic components to provide two-way child–toy interaction to carry out a purposeful task. Many smart toys also aim to exhibit at least some

degree of intelligence, autonomy and agency and in enabling such affordances many require connectivity. Connected toys benefit from access to sophisticated technology such as voice, providing toys that appear to exhibit agency, reacting to the user's actions, identifying verbal messages and responding to them with considerable overlap growing between smart and connected toys. The similarities and differences are outlined in figure 1 and further outlined in the following sections.

2.1 Interactive Toys

Some interactive toys have become traditional, with babies, toddlers and the under 10s regularly playing with ranges from companies such as Mattel Inc.'s Boppin' Beaver & Sit-to-Crawl Sea Turtle; Magic Touch Drums™ from Baby Einstein, or the Medical Kit produced by Fisher-Price providing sensory and physical interactivity - sounds, lights and action (Fig 2).

Fig 2. Interactive toys for toddlers

Children's versions of cameras, Walkie-Talkies and Laptops, such as Vtech's toys enable pretend play as adults with child centred content (Fig 3). However, although most interactive toys for younger children claim to be both highly playable and educational, in studies where parents and young children engaged with interactive toys (McReynolds et al., 2017) the toys were typically found to be somewhat limited and where they have a pre-determined set of responses could quickly become boring. In defence, for pre-schoolers such repetition of play activity is often desired by the child. And further, much interactive toy functionality is overlooked with toys used for only a limited set of specific purposes, ignoring many of the features provided by the product, in the same way that adults ignore many features offered by software or devices (Goldstein, 2012).

Interactive toys can extend existing toys, providing more features and opportunities for play, such as interactive stacking blocks that enable colour and matching play as well as construction (Sridhar, Nanayakkara & Huber, 2017). Toys can also provide an alternative to screens, for examples, a recent toy innovation has been to provide tangible interface screen free audio toys, such as Toniebox, providing music and games activated through toy figures. For older children, current toy technology trends include extending physical toys with Augmented Reality, such as Lego's Hidden Side universe, where buildable models are integrated with an AR app. Interaction with the Haunted Fairground model, for example, triggers events in a digital world, such as a roller

coaster ride, experienced through a phone or tablet. Although this may add significant play value and more toys of this type are anticipated, whether this will be another short-lived toy fashion such as the 'toys-to-life' gaming genre is not yet clear. For all ages, app-enabled toys such as Play Impossible's sensor- based Gameball provide somewhat novel interactive physical play albeit at a premium price.

Fig 3. Pretend play - Vtech's toys for kids (www.vtechkids.com)

2.2 Smart Toys

As AI and robot technology has become more affordable, it has been incorporated into a wide range of children's toys to provide new and personalized play experiences. Smart toys come in different shapes and forms from having their own intelligence by virtue of on-board electronics, to those of one or more microprocessors or microcontrollers, volatile and/or non-volatile memory, storage devices, and various forms of input–output devices. For example, the *Sphero* robotic ball can be played interactively or driven with an app. Other smart toys use intelligence in creating a relationship with the child e.g., the *Cozmo* and *Vector* robots have personality and intelligently respond to player interventions in great detail or can even prefer to ignore or correct their actions.

Smart toys may be networked together with other smart toys or a WiFi in order to enhance play value or educational features. For example, using LittleBits' electronic blocks technology and the free Droid Inventor app, children can teach their R2 Unite robot and take it on missions in the Star Wars universe. Likewise, Artie 3000 is a drawing robot designed to teach children how to code (Fig 4). Smart toys have intelligent characteristics, such as being able to speak or undertake purposeful tasks, often claiming to support learning particularly in Science, Technology, Engineering and Maths (STEM) subjects. Although toy robots, such as Gilobaby that talk, dance and sing are popular, more interactive social robots such as Nao are too expensive for most families or where 'affordable' models exist, there is simply a lack of take-up. For example, targeting older children, Vector, the affordable, internet-enabled, voice-controlled, app-connected robot has been discontinued with only limited support still available.

Little Bits R2-D2 Star Wars
littleBits
https://sphero.com/

Artie 3000 The Coding Robot
Educational Insights
https://www.educationalinsights.com/

Fig 4. Smart robots

2.3 Connected Toys

Connected toys are interactive and smart, connecting via the internet to retrieve information, exchanging data between a child and a server or an internet platform. Connected toys afford high agency providing toys with capabilities to address player's interactions and interventions, a context where the child feels empowered to take the actions, they want in anticipation of getting an appropriate and enjoyable response from the toy. Connectivity requires information or data to be exchanged between the child and the server and there had been great expectations of how play and toys may change, with opportunities for connected play (McReynolds et al., 2017). However, few toys are connected and toys that require local connectivity using Bluetooth for Karaoke games or walkie-talkies, continue to have well-publicised security flaws. Unauthorised devices being able to pair with such toys were reported in Laughlin (2021). Concerns about smart toy data safety and security have led parents to assume there are many flawed smart toys available. In reality, most reported security issues are identified by ethical hackers and not actually exploited. Nonetheless perception matters, especially around which toys parents allow their children to have.

Media driven security issues are currently driving caution in the toy sector and with such challenges, there are currently very few connected toys. For example, Children's Code of Connected Toys and Devices (Information Commissioner's Office, Sep 2020) is applied to all devices, including toys, which collect personal data and transmit it via a network connection. In their guidance only a single example of an internet-connected toy, a teddy bear, is provided. Thus, although interactive, smart and connected toys apparently offer innovative and novel ways to play and learn, the interactive toy market is contracting, with most innovative products rarely lasting more than a few years before being withdrawn from sale. And usually not because of a data leak or a security issue but simply because there is insufficient market for a high cost, often limited functionality product.

A recent innovation that may have a significant impact on the toys sector achieved through Amazon's 'Alexa Everywhere' initiative enabling toy makers to use existing home technology, with Amazon Echo-enabled toys beginning to emerge. One of the first is Gemmy's Twerking Bear (Fig 5), a dancing and talking bear paired to an Echo device that lip-syncs Alexa's spoken words, however, this is currently only available in the USA. More ambitious is Kidcraft's Alexa-enabled Kitchen and Market (Fig 5), where items and surfaces have electronic

tags and sensors which allow Alexa to become a playmate of sorts. For example, if the child places a lettuce on the scale in the market, Alexa will start discussing salads and what else they need to buy. Still in development, this type of toy could offer a new way to play although as of yet, there is neither the toys nor the uptake, with a premium price tag anticipated for Alexa to know the child has switched their attention to the fruit section and come up with an apple pie recipe.

Fig 5. Kidcraft's Alexa-enabled Kitchen and Gemmy's Twerking Bear

With connected toys, (Information Commissioner's Office, Sep 2020) clear guidance is that a smart, connected toy or device must conform to GDPR. However, such conformance will still allow for the collection of extensive amounts of data, potentially with children's play utterances, practices and lives stored digitally on corporate servers (Van Dijck 2014). This brings concerns related to possible uses and monetisation of data for marketing and advertising (Stephane et al. 2016). However, more important than this for the future of interactive toys is whether children, the intended users to actually want to play (and thus potentially learn) with the interactive toy.

2.4 Interactive Toys and Learning

There is an array of research on the positive impact and relationship between toys and learning (Ihamäki & Heljakka 2018) with children who have access to a range of toys had higher levels of intellectual achievement (Goldstein, 2012). According to research conducted in the home, availability of play materials during formative years is directly related to cognitive development in infants and pre-schoolers, with the availability of toys in infancy being related to the child's IQ at three years of age. Studies have shown that toys improve cognitive development, thus, increasing learning and there is the assumption that interactive toys not only provide learning, but that this learning is somehow better or perhaps more constructive because of a toy's interactive feature. However, even though this assumption exists, there are very few interactive toy studies outside of studies on children with special educational needs and disabilities. For toys that claim educational benefits, these are very rarely backed up with an empirical study that demonstrates educational benefit, even where this may be the primary selling point for the toy.

Ekin, Cagiltay, & Karasu (2018) conducted a small-scale study to analyse the usability of smart toy technology, focusing on how to properly integrate the toy into a learning environment for intellectually disabled children. They found that children learn quickly whilst playing with smart toys. Similarly, Abdi & Cavus (2019) developed an educational toy for pre-kindergarten children to help them teach English as a second language in Iraq. The toy determined the learning capabilities in terms of letters, numbers, words, colours, and shapes in the English language. The results showed that after using the toy for 4 weeks, children learned all the numbers, alphabets, colours and shapes. Likewise, Ihamäki & Heljakka (2018) have found that the interactive dialogue with smart toys is very helpful in learning vocabulary, math, geography and science. The play pattern and

storytelling features also contributed to children's social-emotional development, boosted their creativity and imagination.

Yilmaz (2016) examined the cognitive attainment of children by using educational magic toys (EMT) developed with augmented reality technology. Güngör (2018) focused on determining the educational impact of using an English talking toy on children's receptive and expressive vocabulary learning. Half of the participants were in the control group that was instructed using flashcards and the other half were in the experimental group that was instructed with talking toys. After the experiment, there was a statistically significant difference between the experimental and control group confirming the effect of the English talking toy on improving vocabulary learning. Noor et al., (2017) designed a Children's Storybook Reading System, (StoBook), for children with learning disabilities in reading, aged 7-12 years old to motivate them to learn. The application teaches children to recognize letters and spell words, thus, stimulating the learning process. It helped children with learning disabilities to learn with fun because it required them to move their hands, eyes and the other organs. Jeong, Saakes, & Lee (2015) developed an interactive toy set aiming to teach new (second) languages to young children between the ages of 3-5. The toy was a plush doll that spoke sentences related to the objects that are nearby and asked children for other related objects. In this way, both active and passive vocabulary are practiced.

Kara & Cagiltay (2020) sought to design, develop, and use a smart toy for preschool children from 36 to 72 months old. The toy was evaluated on the cognitive attainment domain and the researchers found out that for the toy to be cognitively accessible to children, it has to use only one pattern on each screen and to start from the basic pattern, making them more difficult in later scenes. The content must be clear and easy to understand for children. Theofanopoulou et al., (2019) designed a technology-enabled intervention for children to support their emotional regulation efforts. The study found that the smart toy was incorporated into the children's emotional regulation practices and engaged with them naturally in moments when they wanted to relax or calm down. Children also developed a strong emotional connection to the toy and because of that they found the experience enjoyable and wanted to keep the toy for a longer time. All the families reported that interacting with the toy had a positive impact on children's moods and instilled a sense of responsibility in them. The children naturally interacted with the toy to self-soothe after an emotion-eliciting situation, such as a conflict with their parents. It was also reported that having the toy had an overall calming effect, with children appearing a lot calmer or more settled over the duration of the deployment.

3. Methodology

Interviews involving n=15 experts from universities, technology corporates and stakeholder organisations to explore their perspectives on near-future technology in the home and family were held. The sample consisted of 8 academics, 6 based in the UK, 1 in the US and 1 in the EU. All of the academic experts were at Universities, with 5 in Computer Science, 2 in Media / Policy and 1 in Design. Experts had expertise in fields including child computer interaction and participatory design; digital and online implications and policy for children and teenagers; and content creation for children and teenagers. All of the academics had contributed to leading conferences and journals in their fields. The 7 industry experts were all based in the UK, primarily in London from major tech corporates and stakeholder organisations. They included 4 technologists with expertise in connectivity and emerging technology trends for the home and family along with 3 experts from the toy sector, regulators and stakeholder organisations supporting the digital experiences of children.

The semi-structured interviews lasted for an hour and were audio only. They included consideration of the connected home and family and particularly expectations for three specific technologies: Virtual Reality, Voice Assistants, see (Hall, 2020), and as reported here, Interactive Toys. The interviews were tailored to meet the experts' areas of expertise with questions about interactive toys including:

- **Current and future expectations of interactive toys for play**: What types of interactive, smart and/or connected toys will emerge in the next 3-5 years? What sort of play, games, entertainment and experiences will they be providing? Will increased use of interactive toys impact on family dynamics?

- **Current and future expectations of learning through playing with interactive toys:** How will interactive toys be used to support children's play and learning? What sort of skills e.g. physical, creative, social, academic? Will there be increasing use of interactive toys in the classroom? What benefits and challenges are there in replacing, changing and/or enhancing family or classroom functions through interactive toys? What are the implications for children's social and emotional behaviour and learning?

- **Evidence of educational benefit**: How should the appropriateness of the toys be assessed for the intended use? Are you aware of any research that demonstrates the educational benefit of commercial interactive toys? Are you aware of how purchasers demonstrate that toys meet educational expectations and/or safety, security and privacy requirements?

- **Challenges, Risks and Concerns**: What are the risks and concerns with interactive toys and their data in the immediate context of use and in longer term security and use of the data? And what are the benefits? How do we ensure that interactive toys meet regulatory standards? How do we educate parents and families in assessing the toys available in the marketplace? Who is responsible for safety?

- **Involving users**: How do interactive toy makers involve children, teenagers and families involved in the design, development and evaluation of interactive toys? How much are users' opinions and requirements solicited or listened to for the design of interactive toys? What do children, teenagers and families think about interactive toys, safety and security in the home?

The interviews were held between November 2019 and March 2020 (pre-COVID) with the interview data recorded and transcribed for later analysis. Unique references or codes were assigned to respondents in order to keep their confidentiality. The transcripts were coded using a 'Template Analysis' approach which is a style of thematic analysis and involves the development of a hierarchical coding template from initial data analysis that can be further refined as it is applied to the full data set (Brooks et al. 2015). According to Yang & Kang (2018), the procedures of thematic analysis include three major stages: identification of broad themes, subthemes and their naming. To help identify broad themes, attention was paid to forcefulness, recurrence and repetition in the data. Once both broad and sub-themes were identified, names were assigned to each theme and sub-theme to describe their meaning. It followed a process of reading and conducting a preliminary coding on a subset of transcripts. As the initial template was applied to the data, it was modified and reorganized as needed with the REA providing additional help in understanding the transcripts.

4. Results from Expert Interviews

Word clouds and cluster dendrograms were used to give an overview of the most common words identifying that the main focus had been on the use of interactive toys for thinking, learning and knowing. Technology, innovation and technological advances had few mentions in comparison to words such as hack or safety. The experts focused mainly on the potential of interactive toys for learning with relatively little consideration of aspects such as play and fun. This was confirmed by the Template Analysis of the 15 transcripts that revealed 5 broad themes as outlined in Table 1 and further discussed below.

Table 1. Major Theme, Sub-themes and Indicative Quotes

Themes	**Sub-themes**	**Indicative Quotes**
Educational Utility - **Toy as way to learn** (21)	Academic learning	*"...also, there can be educational, actual learning attributes, like the wide-open objects and the toys can be small and they can also be educational...so you just hope the connectivity reaches the educational benefits."*
	Moral, social & emotional learning	*"...emotional and social skills whatever it is will sort of benefit from the interactive toys."* "children learn about caring even with a teddy"
	Learning as Play	*"a kind of inter-relationship to how we support young people to play and how they learn.*
	Beneficial for disabled children	*"...making it more accessible and easier for families to play."*
Children of busy parents **Toy as way to entertain** (4)	Way to enable solo activity	"*Yeah, I think most parents think that's what it's for and that they don't need to be there because it's something that the child will do on his or her own with the interactive toy and they do with the other toys.*"
	Safe to use	"*It's finding a quick and easy way to keep your children amused and sort of feel like you might be doing something good because they happen to be playing on something that is teaching them something.*"
	Consequences of lack of human contact on the child	*"...the reality is that we are all busy parents and actually taking that risk factor is actually really helpful"*
Integrative (2)	Communicative, assistant Single device with default voice	*"...What you could have is the interaction where the child could say something to the toy and the toy then can communicate back and they could then simulate battles and role plays and things like that with actual the characters and so on with respect to voice recognition."*
Safety and privacy (5)	Products have safety issues	*"You know we found toys…that have serious safety issues with them."*
Evidence of Educational Utility (3)	No learning benefits, merely a claim	"*it would be harder to prove that interactive toys didn't have a learning benefit, after all you can learn by playing with a stick."*

The analysis identified that experts focused on the educational aspects of interactive toys. The most spoken about theme was Educational Utility – the potential of the toy to provide learning with all experts mentioning this and 21 quotations identified in the transcripts. The least spoken about theme was Integrative Features with only 2 experts providing quotations.

4.1 Theme 1: Educational Utility:

Experts agreed that interactive toys provide a way to learn and have educational utility. Even the experts who were less convinced agreed that children are learning through playing, with general consensus from the experts that for younger children interactive toys, such as those targeting sensorimotor and imaginary skills provided learning through stimulation and play. Expert views about the effectiveness of interactive toys for learning and education or their educational utility resulted in 4 sub-themes as presented in Table 1 along with indicative quotes. Within Educational Utility, the most common sub-theme was Academic Learning with a total of 7 quotes and the least common theme was Children with Disabilities with a total of 2 quotations (see Table 1).

The experts agreed that most interactive toys provide at least some opportunity for children to learn academic and/or cognitive skills. Experts identified that interactive toys provided academic learning such as literacy and numeracy, particularly with early years skills such as alphabet recognition. Experts mentioned that interactive toys were useful in teaching children about grammar, spelling, and numeracy and in learning about the world, for example, interactive toys help teach children about colours.

Although the experts agreed that interactive toys would support learning, there were concerns about whether interactive toys, particularly those with fixed routines and purposes, develop creativity and imagination in children. Other experts took an opposite view and emphasized that play is an important part of learning, inspiring creativity and sparking curiosity in young children.

In addition to academic learning, experts mentioned that through interactive toys children develop moral, social, and emotional learning. Many mentioned care toys, such as interactive teddy bears and other typical mascots, with limited built in routines that enable the toy to respond to being cared for or played with.

Some experts highlighted the benefits of interactive toys for children with Special Educational Needs and Disabilities. The potential of such toys to offer innovative learning approaches was highlighted along with several examples, particularly for toys to support children with severe disabilities, such as experiential sensory play rooms, Toys for neurological conditions such as cerebral palsy, where play can significantly support development, were also identified. It was identified that unlike mainstream interactive toys that this was a sector where there was innovation.

A number of experts also noted that interactive toys were not always engaging or playful, particularly for older children with anecdotal accounts of toys not played with and discarded, often high-cost interactive toys.

4.2 Theme 2 - Children of busy parents

Experts agreed that interactive toys provided a useful way to keep children occupied so that parents can free up time, particularly to deal with household tasks and organisation while at home. The concept of the interactive toy as provider of solo play was viewed as "*legitimate*" and in line with play with other toys: "*Yeah, I think most parents think that's what it's for and that they don't need to be there because it's something that the child*

will do on his or her own with the interactive toy and they do with the other toys."

The educational utility of interactive toys was also highlighted as a rationale for solo play: "*It's finding a quick and easy way to keep your children amused and sort of feel like you might be doing something good because they happen to be playing on something that is teaching them something.*"

Experts considered interactive toys to be generally safe, although some raised concerns about *"disreputable manufacturers"* selling sub-standard and unsafe toys via online retailers such as Amazon. Although the concept of the interactive toy that would really support solo play was discussed all of the experts agreed that the technology was not yet up to the task.

The key role of the adult in engaging in that play was identified by some experts who highlighted that children need to learn to play and to practice play with adults. Some experts did have concerns of leaving young children with interactive toys. However, as several experts commented young children frequently spend significant amounts of time engaged in solo streaming (with the algorithm providing what used to be the parental interaction).

With interactive toys and the belief in inherent educational value, leaving the child actively playing with an interactive toy is somehow better than a child passively watching an iPad. As one expert commented:
"…the reality is that we are all busy parents and actually taking that risk factor is actually really helpful"

4.3 Safety and Privacy:

All of the experts were aware of safety and privacy issues and concerns related to interactive toys, such as being "*easy to hack, revealing unencrypted data including the child's name, weight, date of birth, and the parent's phone number.*"

In the interviews, most experts were much more aware of the concerns and flaws relating to connected toys and discontinued products such as Hello Barbie, My Kyla, the walkie-talkie, etc. than of what the toys had been for or the lack of currently available connected toys.

Experts had "*found interactive toys [in a recent study] that have serious safety issues with them*." And others had seen flaws exposed through ethical hacking: ".. *none of these toys are secure in any way and that's the issue so we've got big security and cyber hacking and the connected doll and [a colleague] demonstrated how easy it is to hack into one so I think that is a real issue."*

Experts agreed that there was a need for regulation and enforcement: *"I think we do need time to regulate standards around [interactive toys] … minimum standards that products have to meet like electrical safety standards."*

Experts agreed that *"big toy selling platforms like Amazon just voluntarily adopt some sort of code of conduct that works out digitally enabled toys, that they meet some sort of minimal standards."*

Experts were also concerned about the porosity of the home, about family privacy and in particular where the data was going: *"…Alexa becomes the de facto voice assistant in all toys, then there's no way that Amazon's not going to be receiving all the data."*

4.4 Theme 4- Integrative Features

Experts spoke about the complex interconnectedness of different technologies that could be useful for innovation in the toy sector, although few had seen any examples. Voice-interaction was seen as having potential:
"*I think potentially yes, particularly for the younger age range and things…What you could have is the interaction where the child could say something to the toy and the toy then can communicate back and they could then simulate battles and role plays and things like that with actual the characters and so on with respect to voice recognition*."

However, most experts included those in the toy sector expected little change in interactive toys in the next three to five years. The expectation was for new interactive toys to continue to be "*predicated by other media, such as films, or as this year's 'must-have' techno-gift"* resulting in the acknowledgement that interactive toys were often quick to come and go, a rebranded existing product rather than an innovative development.

Several experts were not convinced that innovation would come through the convergence of technologies such as voice and augmented reality integrated into toys, but rather through some *"unexpected breakthrough, some new way to play that we didn't expect.".* Most experts commented that children of all ages were more likely to be playing with tablets, smartphones or consoles than with interactive toys.

4.5 Theme 5: Evidence of Educational Claims

Towards the end of the interview, after experts had discussed the potential for interactive toys for learning, they were asked specifically if they were aware of any evidence that could underpin the educational claims made by interactive toy manufacturers. No expert was aware of any such evidence, not even those within the toy sector or engaged in interactive toy research and development. Comments included: *"I'm not aware of any. No" "Yeah good question I am not sure … certainly not as I've seen." "Surely, it's all written to back up their clients, isn't it? Or maybe not…''* However, as one expert commented "*it would be harder to prove that interactive toys didn't have a learning benefit, after all you can learn by playing with a stick.*

5. Discussion

There is a lack of literature and empirical studies available on the educational benefit of interactive toys with relatively few previous studies on expert views on interactive toys. Such studies, for example, (Chaudran et al, 2017) have recently focused on safety and privacy implications rather than use. Hence, the purpose of this paper was to gain insight into the thoughts of the experts about interactive toys.

Although there is a lack of empirical evidence for the educational value of interactive toys, they are inherently viewed as educational, with experts seeing them primarily as learning rather than playful devices. Experts agreed that educational benefits were likely, but none were aware of any direct evidence to support nor refute such claims. Experts were challenged and surprised by their inability to identify studies and evidence of learning with commercial interactive toys. Academic experts were aware of studies of experimental lab-created interactive toys. However, such studies were typically one-off engagements, with studies focusing on usability rather than learning. Long-term engagement with commercial interactive toys has received hardly any attention, neither in academia nor industry, resulting in educational claims, and at least part of the rationale for adults in purchasing toys being based on an unsubstantiated marketing message rather than concrete evidence.

The need for interactive toys to add value through learning reflects a diminishing societal interest in providing children with opportunities to play, with children receiving less parental support for play than previous generations (Goldstein, 2012). Although Article 31 of the Convention on the Rights of the Child, explicitly

states that “Children have the right to relax and play,” more rushed family lives, greater focus on formal schooling and homework from a younger age, along with many children’s lives now punctuated by scheduled activities such as clubs and sports had significantly reduced time for play. Now, with COVID-19 the context has changed considerably, with everyone spending much more time at home. Even so, this doesn’t necessarily equate to more time for parents to play with their children. Instead, as discussed by the experts, often in a personal as well as a professional capacity, busy parents will legitimately be looking to interactive toys to entertain their child to give them time to undertake the many tasks of everyday life.

There is a general sense that interactive toys are ubiquitous and that play, just like many other activities, is becoming technologized. However, although most children do engage with interactive toys for sensorimotor and pretend play, such toys emerged at least a generation ago. A stultification in innovation has occurred in the toy sector as a response to ill-fated attempts to integrate connectivity. Innovation has been further reduced through a lack of collaborations between toy makers, tech corporates, academics and entrepreneurs along with the lack of research into interactive toys. The lack of exciting interactive toys along with the limitations in interactivity, playability and responsiveness, have left a significant gap in the connected home.

Due to advances, particularly connectivity, children are nowadays exposed to considerably more technology compared to previous generations. However, somewhat surprisingly, there are few interactive toys and although technologies do exist that could increase a toy’s ability to respond and interact as of yet they have not been integrated for play. Our third recommendation focuses on the need for innovation and collaboration to enable interactive toys to be developed that could be novel and relevant, such as toys for building play skills in children, or toys designed with features that enable children to be creative and imaginative. However, as of yet we are still waiting for such innovations to occur. Similarly, although the marketing for most interactive toys implies solo play, there is real potential for interactive toys to provide a bonding play element, where the play aims to engage both parent and child through the interactive toy. In this way, the child will be playing and /or learning from the interactive toy and will also be spending quality time with the parent, thus, enhancing their bond. And in the connected world, this could be so much more than enhancing a parental bond, with mics, voice, tags and sensors play could readily be across households.

To do this a change in perspective is needed, even the innovative Alexa-enabled kitchen still focuses on the child playing alone, transporting the child as a player into the imaginary world of the toy. Now families need something different - connected toys that can transport others into the ‘real’ play world of the child. This is almost a perfect scenario for the Internet of Toys, but caution – pragmatic and inclusive innovation are needed. Smart toys need to be made for the many families with mediocre tech and limited disposable income rather than the few who want premium products with sophisticated AI. This offers a clear opportunity for toy makers, technologists and researchers to add value to remote family and intergenerational relationships as well as bringing play into the connected world.

Recommendation 1:	A fundamental requirement is based on the expectations of children and parents that interactive toys are safe, secure, regulated and compliant. The enforcement should be proportionate, sufficient and highly publicised to establish compliance. It must include the proper treatment of data to create safe devices for children and families to play and learn with.
Recommendation 2:	There a significant need for interdisciplinary and intersectoral research exploring the educational claims and potential of interactive toys. Such research needs to incorporate a range of methods from empirical to speculative. It needs not only to consider the interactive toys of the lab but also to encompass longitudinal and

empirical studies with commercial interactive toys in the home. It needs to be broad, covering a wide range of users, from experts as in this study others including stakeholders, policy makers, parents and children.

Recommendation 3: Greater innovation is needed with the toy sector, this will be much increased if the toy sector increased collaboration with academia and particularly with the technology corporates. There is a need to gather and explore playful verbal and physical data, enabling toymakers and technologists to understand how to design connected toys with significant play value.

Conclusions

This paper has reported a study into expert views and perspectives of interactive toys. This has highlighted that there is an existing, unsubstantiated belief that interactive toys are on the increase and that they are an effective way to learn and engage in solo play. Despite a lack of scientific evidence, it is likely that such educational claims are at least partially valid and that interactive toys offer significant and untapped potential for learning through play. Currently, in a world that is so connected and where technology innovatively mediates across most aspects of life, there remains a lack of novel interactive toys, with real opportunities available for changing play using connectivity, the Internet of Toys and voice-enabled interaction. To achieve this and to provide children with new ways to play and learn demands increased collaboration between researchers, toy makers, technology corporates and innovators.

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