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Interactive storytelling for children: a survey

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Abstract: This paper provides a review of past and present research in interactive storytelling in relationship to children. It investigates the field of Interactive Storytelling for Children (ISC) along multiple perspectives, considering theoretical approaches, design methodologies, and technological solutions that regard children as interactive story authors. It highlights how ISC draws significantly on principles, methods, terminology, systems, of two more consolidated disciplines, Interactive Digital Storytelling (IDS), and Interaction Design for Children (IDC). Finally, the paper attempts to identify the peculiarity of ISC as an autonomous discipline and pinpoints some research challenges of this domain.

Keywords: digital storytelling; interactive storytelling; children.

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1 Introduction

Storytelling is the ancient art of creating and communicating narrative structures of words, images, sounds, or actions, as a means to entertain, preserve a culture, or educate. Storytelling, meant as listening at narratives created by others, or as creating own stories, is something human beings experience since early childhood. With the advent of interactive multimedia technology, traditional – paper-based or oral – storytelling has evolved to digital and interactive storytelling, which has become increasingly popular for children. Children can play as interactive story 'consumers', who engage with multimedia narrative stories delivered on different platforms and tools, from interactive books off-line or on the web to storytelling-based computer games and speaking toys. Or they can be engaged as 'creators' of interactive stories, individually or in group. In both

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cases, interactivity has the potential of increasing enjoyment, and fostering new forms of creativity, social activities and learning.

The appealing mix of elements – technology, narratology, and children issues – has triggered the development of a new, multidisciplinary research field, hereinafter referred to as 'interactive storytelling for children' (ISC for short), which has witnessed a rapid advancement in the past few years. In the rest of this paper, we present a review of the most relevant research results in ISC, to provide researchers and practitioners in the field with a reference literature framework about existing technological and methodological approaches. Our review approach is focused on theoretical approaches, design methodologies, and technological solutions that regard children as interactive story *authors*, although in many reported works the authoring activity is often intermixed with activities of story exploration. We highlight how ISC draws significantly on the principles, approaches, terminology, and technology of two more consolidated disciplines, *Interactive Digital Storytelling* (IDS), and *Interaction Design for Children* (IDC). In addition, we attempt to identify the peculiarity of ISC as an autonomous discipline and pinpoint the challenges of this domain.

2 A review of state of the art in interactive storytelling for children (ISC)

In this section, we explore the ramifications of the concept of 'interactive storytelling', first in general terms and then progressively focusing on interactive storytelling for and with children.

2.1 Contributions from interactive digital storytelling (IDS) and related fields

The IDS field builds on the tradition of several research disciplines, the ones bearing most influence being generative computer graphics, human-computer interaction (HCI), and artificial intelligence (AI) (Spierling, 2005). Two concepts characterise IDS: interactivity and authorship. *Interactivity* in IDS encompasses the end-user experience: by interacting with a responsive system, the user can determine the course of the narrative (Spierling et al., 2002). In what *authorship* is concerned, the demarcation between user and author is not clearly delineated. The user's active role in determining the narrative course can be described as an activity of co-creating the story (Spierling and Szilas, 2009).

IDS has been described by Crawford, one of the pioneers in this domain, as "a form of interactive entertainment in which the player plays the role of the protagonist in a dramatically rich environment" (Crawford, 2004). This quite specific definition indicates the concern of IDS researchers with producing user-responsive systems by calming the tension between narrative coherence and user's active input. Research concerned with developing user-responsive intelligent systems on dramaturgical models is sometimes termed 'interactive drama', building on the legacy of the dramaturgical model of HCI proposed by Laurel in the acclaimed book 'Computers as theatre' (Laurel, 1991). Szilas defines interactive drama as "a narrative genre on computer where the user is one main character in the story and the other characters and events are automated through a program written by an author." (Szilas, 2005; see also Mateas, 2002). The coming into being of IDS can also be related to experiments carried out in interactive cinema,

especially visionary being those developed at MIT (Davenport, 1994; Cavazza et al., 2008).

The full development of IDS cannot have been possible however without leaning on AI technology. The AI-enhanced interactive story is a responsive digital system of intelligent agents animated by a runtime engine and delivering content under the form of a story world. In AI-based systems, however, pure authorship is not located in the user's, but rather in the hands of the story author (responsible for the actual development of content and narrative structure) and the digital system designer (developer of the storytelling system on which the narrative structure and the content are emulated). Authorship itself, as Spierling and Szilas (2009) argue, is very different from the traditional notion of creating a story using conventional media. Rather than defining a course of events the author is put in the position of defining the rules that govern the system, constrained by the features and capabilities of the IS authoring software used. In this context, given the complexity of story creation, which requires sophisticated procedural knowledge, the role of children is limited to that of active users, or interactors. While this process can be deemed to be an activity of co-creation, we cannot speak of children as story authors in the field as delimited by the use of AI technology. Middle-paths can be conceived, by ruling out AI technology. In designing story authoring software that is accessible to children, the absence of AI technology, as suggested by Bates et al. (1995), can be supplemented by other features, such as the use of believable characters, which can trigger emotional response and account for the limited range of interaction they offer (Bers and Cassell, 1998).

Children authorship is given a much more important place in studies pertaining to the IDC research field, as discusses in the next subsection.

2.2 Children as interactive storytellers

The development of storytelling technology in the IDC community is subsumed to the imperative of "taking into account children's abilities, interests, and developmental needs" (Hourcade, 2008). In here as well the distinction between direct authorship and interactive exploration of content is not sharp and several hybrid forms mixing interactive exploration and authorship can be identified.

Some systems, for instance, allow children to create stories based on an existing database of elements (e.g., StoryBuilder, in Antle, 2003); others mix story exploration with story creation; the degree of interaction with a technological device or space in constructing a story might also go from acting as a mere repository of digital memories with annotation functions to active support for story creation. Where should we draw the line? In a widely cited article by Cassell and Ryokai (2001) the authors make an argument for the need of creating systems that support children's free creativity and play. We build on similar premises by choosing to focus, in the forthcoming part, on a view of ISC that considers children's active role in developing stories animated by *creative intention*. In the remainder of this subsection we are going to focus our review of the literature on those approaches directed at the *design of environments* where children are encouraged to use their creativity to tell, make, refine and share stories.

The review of the children story authoring literature in this part is based on the *level of abstraction* of a contribution, identifying meaningful research results to either *theory*, *methodology,* or *technology* development. We acknowledge the fact that many

contributions, and perhaps some of the most significant ones, would be based on a holistic approach and a progressive exploitation of theory, methodology or technology design. However, we have focused on meaningful and transferable contributions in each of these categories, and mentioned where theory, methodology and/or technology development are linked in a given approach.

2.2.1 The use of theory in ISC

The purpose, in this part, is to discuss the major bodies of theory used in ISC research, also in comparison to the theoretical approaches embraced by IDS.

One first observation is that ISC differs considerably from IDS as to the theoretical traditions that are brought to bear. Theory use in IDS is principally subsumed to the development of technology. IDS is drawing extensively on *narratology* and *narrative formalisms* (Cavazza et al., 2008). A review of the main narrative theories for the analysis and development of IS systems conducted by Cavazza and Pizzi (2006) has highlighted five such approaches: Aristotelian (drawing on Aristotle), formalist (drawing on the narrative functions of the Russian folklorist Vladimir Propp), semiotic-linguistic (Greimas), semiotics (Barthes), and character centric (Bremond). Narrative formalisms, argues Cavazza and Pizzi (2006), can influence the entire process of IDS, from story conception to generation and presentation. Other emerging issues in IDS are related to authorship, and especially the gap created by the need to have narrative talent *and* procedural knowledge (Spierling and Szilas, 2009) for being able to develop a story in the limits set by a certain authoring system. Such issues can be approached by drawing on either HCI or media and communication studies.

On the other hand, in ISC, the reference point for conceiving of either technology or experience is shifted, while the scope is enlarged. The focus shifts from technology *per se* to the context, purpose and means of using technology and narrative authorship as means for fostering positive impact on children development. The theoretical frameworks under which child-centred ISC initiatives and systems designs operate are indicative of this concern and integrate insights from *cognitive and social psychology,* as well as *education and learning theory*.

In what education and learning theory are concerned, we point to the paradigmatic shift in the conceptualisation of learning and knowledge acquisition, as it has been summarised by Jonassen and Land (2000), by highlighting three main features:

1 the shift from knowledge transmission with a passive recipient to knowledge building

2 the social nature of the process of attributing significance and meaning making

3 a shift in the position of the agent of meaning attribution, no longer placed in each individual, but in the relation between individuals and the environment.

This is a summary of more than half a century of advancement in developmental psychology and learning theory. Designers of child technology have placed an emphasis on some or more of these key principles.

Freier (2009) summarises the most salient features of the process of child development into six aspects to be taken into account when designing children technology: a technology for an embodied, situated, dynamic, intentional, social and moral individual. Several distinct approaches to the integration of these insights have

developed. For instance, designers of child technology at MIT, especially the research group lead by Seymour Papert, have centred their approach on constructionist tenets, emphasising a 'learning by doing' approach and the importance of sharing and collective meaning making in groups of peers (Harel and Papert, 1991). Other researchers studying the development of children technology (e.g., Decortis and Rizzo, 2002; Rizzo et al., 2003) draw on the Soviet cultural-historical psychology school (Vygotsky, 1978, 1998).

A further aspect to take into account regards the role of the narrative in a child's life and development. Drawing on cognitive and developmental psychology, the role of narrative in child development can be summarised as affecting three levels: the cognitive, the social and the emotional. The contributions to the study of narrative in cognitive, social and affective development most widely cited in ISC research have been made by Bruner (1991, 1996), Schank and Abelson (1995), Wertsch (1998), Vygotsky (1978, 1998).

Most ISC work draws on some of the above or associated theoretical insights in conceiving and designing technology or experiences of engaging children with ISC systems. There are, to our knowledge, few coherent theories that have been developed within and for ISC exclusively. NAM (Narrative Activity Model) is such an example, a model inspired by the cycle of creative imagination of Vygotsky (1998), applied to the phases of developing a narrative: exploration, inspiration, production and sharing (Rizzo et al., 2003). In this special issue, the article by Decortis and Bationo-Tillon (in press) also draws from a sociocultural research tradition as represented by Vygotsky (1998) and Wertsch (1998). The authors propose a conceptualisation of children's narrative activity that emphasises the situated, mediatised and creative properties of the narrative activity, and conceives the process of story authoring as a series of four steps – exploration, inspiration, production and sharing.

2.2.2 ISC design methodologies

The methodological approaches for designing children technology can be separated between those adapted from HCI and those developed especially for children [for an overview of child-centred design methodologies in HCI, see Nesset and Large (2004)].

The design methodologies borrowed from HCI and applied in working with children include user-centred design, contextual design, and participatory design. User-centred design, in which users may be involved for testing or evaluating a technology or service (Scaife and Rogers, 1999) is concerned principally with the impact of technology on child users (Druin, 2002). Despite some advantages (fast process, large numbers of users can be involved), it can only allow limited involvement for children, and only in a position of testers, not initiators. Both contextual design (Beyer and Holtzblatt, 1999), with its emphasis on the environment in which the user is active, and participatory design, which stresses co-design and user engagement techniques, can easily lend themselves to working with children. In this special issue, Weibert and Schubert (in press) provide a vivid example of 'in context' story authoring reporting the experience of an intergenerational group – caretakers and children – working together in the development of a common interactive story in intercultural computer clubs. Participatory design has been used for developing educational games (Magnussen et al., 2003), mobile technology (Brynskov et al., 2005), or medical support software (Ruland et al., 2008). Not all participatory design experiences have proved successful. Jones et al. (2003), report difficulties of employing participatory design techniques with children.

Tailored techniques for children, such as comic boarding (Moraveji et al., 2007), have been developed for meeting some of these challenges. Moreover, fully-fledged child-centred methodological frameworks such as cooperative inquiry (Druin, 1999; Druin et al., 1999) and informant design (Scaife et al., 1997, Scaife and Rogers 1999) have emerged as approaches centred on the needs of the children and their capacity to participate in the design process.

Cooperative inquiry uses contextual and participatory design methods, as well as techniques from other participative methodologies, adapted to working with children. The design process involves intergenerational design teams in which children are treated as full design partners.

Informant-design can be located in between participatory and user-centred design. Children are not considered full design partners, but rather 'native informants' (Scaife et al., 1997); their input is solicited in several points along the design process, for initial domain problematisation, testing design assumptions, and at the end for prototype evaluation (Scaife et al., 1997). Learner-centred design (Soloway et al., 1994) is based on a 'learning by doing' approach, and a vision of the user as learner. Soloway et al. (1994) applied the scaffolding technique used in education to their TILT model (task, interface, learner's needs, tools). This approach has been used by Kafai for designing education technology with children (Kafai, 1999; Nesset and Large, 2004).

In this special issue, a number of papers provide methodological contributions to design, at different degrees. Botturi et al. (in press) propose a process model called DSD (Digital Storytelling for Development), to support the design of digital storytelling workshops in the context of education for children with special needs. The model addresses co-design issues with all stakeholders, supporting adaptability issues to groups and situations, and highlighting the role of fiction as a channel for expression. The paper by Di Blas and Ferrari (in press) focuses the educational benefits associated with the process of authoring interactive narratives at school, but also suggests some guidelines on how to organise the authoring process in real school contexts, pinpointing problems and critical points along the different phases of the process.

2.2.3 ISC enabling technologies

This part will review the most relevant technologies that support children's direct authorship of stories and have been developed purposefully for supporting specifically ISC experiences. We rule out, for instance, off-the-shelf software and hardware that have not been created purposefully for ISC, such as video-editing software, and regular multimedia authoring tools that can be used as well for creating digital stories.

The first examples of software and devices created purposefully for supporting children story authoring were designed to support story writing. Early research developed software such as Catch developed at the University of Harvard (Daiute, 1985), and later commercial products such as Kid Works Deluxe (Davidson & Associates, 1995), encouraged and supported children's story writing by providing either illustrations or sets of predefined characters as inspiration. In the past two decades, research in ISC technology has taken advantage of technological advances, as well as new theoretical insights around the role that the child can play in engaging with technology and storytelling.

A wide amount of research tackles the challenges and rewards of using alternative technological platforms for ISC. Interactive storytelling experiences do not restrict to the

keyboard/mouse/desktop screen paradigm; especially in informal settings, interactive storytelling can be supported by a wide array of technological solutions for capturing, editing, exploring and sharing narratives. The use of different tools incurs differences in the dynamics associated with the creative process, as well as in the effects and consequences generated.

An important paradigm of research in ISC and child technology design regards the integration of physical objects from the child's familiar environment. Remarkable advancements of this approach have been done since the 1970s by Seymour Papert's research group at the MIT. One of the results of this research line is the LOGO programming language for children. A concept stemming from a similar concern is that of 'digital manipulatives', computationally enhanced versions of physical objects (Zuckerman et al., 2005). Examples are MIT Media Lab's Digital MiMS (Zuckerman et al., 2005). Other research draws on children engagement through play, and focuses on developing robotic toys, such as Rosebud (Glos, 1997) and SAGE – storytelling agent generation environment (Bers and Cassell, 1998). These augmented toys can be used as mediators in storytelling experiences, and in some cases are able to support complex interaction modes.

Full-body immersive experiences can be supported in room-sized interactive environments such as KidsRoom (Bobick et al., 2000), where children can enter a story world and interact with it physically. StoryRooms (Alborzi et al., 2000) developed by the University of Maryland, further supports children story authoring and sharing. In POGO (Rizzo et al., 2003), physical objects are used as access interface for a virtual story world. The system enables complex activities, by supporting recording, editing, visualisation and sharing of stories in real time.

With regard to the type of platforms and input devices used, other lines of research pursue engagement in story exploration and authoring in 2D or 3D environments, such as for instance FaTe2 (Garzotto and Forfori, 2006), Teatrix (Paiva et al., 2001) or Wayang Authoring (Widjajanto et al., 2008), mixed reality environments (Steiner and Moher, 2002), or mobile technology (Quinn et al., 2009). In this special issue, Fails et al. (in press) explore *mobile* technology for supporting group story authoring. They provide concrete lessons learned while designing, developing, and evaluating 'Mobile Stories', a narrative system which allows children to read, create, and share stories on mobile devices, and provide an overview of previous work in the arena of mobile storytelling for children.

The involvement of groups of children in *shared* storytelling experiences represents an increasingly important line of ISC research. Several expressions are used in the literature to refer to the creation of narratives in groups of peers, such as for instance 'shared narrative', 'collective storytelling', 'collaborative storytelling', or 'cooperative storytelling'. Each of these expressions denotes a minimum degree of collaboration in story authoring, in synchronous or asynchronous mode. One pattern of asynchronous collaboration to story authoring is inspired from the add-a-sentence-to-a-story activity pattern, by StoryBuilder (Antle, 2003) or Renga (Cassell and Ryokai, 2001). A synchronous collaboration can also be done by creating spaces of inspiration through listening, retelling or being inspired by the story of peers [e.g., StoryMat (Cassell and Ryokai, 2001)]. Synchronous collaboration in story authoring can be supported in virtual environments (Garzotto and Forfori, 2006; Steiner and Moher, 2002), or by

custom-designed applications such as KidPad (Druin et al., 1997), a desktop collaborative drawing application which employs a ZUI (Zooming User Interface) paradigm.

3 Conclusions

This review is not meant to be exhaustive. Its main goal is to pinpoint the richness in approaches, initiatives, case-studies, which have emerged in the last year in the field of ISC. At the same time, together with the whole set of papers reported in this special issue and the discussions emerged during the ACM IDC workshop that originated this special issue, this survey aims at promoting a better understanding of the gap between what we know and what we need to know in the ISC domain. In particular, we can identify some research challenges that represent promising research direction for further exploration, including (but not limited to) the following:

- *The context of use.* We need to achieve a better understanding of interactive storytelling technologies and methodologies in relationships to specific contexts of use for children. In particular, it is important to distinguish between formal and informal contexts (e.g., regular school activities vs. outdoor educational activities or home use), to identify more systematically the requirements of the different situations of use, e.g., by developing comparative studies in different contexts.
- *'Social' issues in children's storytelling.* The term 'social' can be explored along multiple declinations. We can approach children's interactive storytelling as a social process and identify issues and patterns related to the dynamics of multiple children's participation and to the context in which multi-user storytelling activities take place. From a different perspective, storytelling activities can also be regarded as a means to promote participants' attitude towards social issues, or as a process that can be integrated into existing social development programs, or as an opportunity to involve the community beyond the immediate storytelling participants, such as for example the family. Finally, an important 'social' issue is the exploration of interactive storytelling in relationship to inclusion and children with special needs, as discussed below.
- *Inclusion and Special needs*. In general terms, digital inclusion is the attempt to ensure all those who wish to access new technologies and the benefits that they bring are able to do so, irrespective of income, ability or disadvantage. In the context of children, this concept is typically explored in relationship to disabled or socially marginalised kids. For interactive storytelling, some of the aspects that are worth more systematic exploration are related to the differences made by working with this target group: At which degree storytelling technological and methodological results achieved with and for 'regular' children can be applied to or adapted for subjects with special needs? How much of the results obtained from work with special groups can be leveraged to 'regular' children? Furthermore, digital inclusion can take additional forms and address a larger audience of children beyond those who suffer of some form of disability or socio-cultural marginalisation. As pinpointed in (Garzotto and Schelhowe, 2008),we are witnessing an increasing phenomenon among young generations, which does not result from having no or limited access to ICT, but is produced by remaining *only a user* vs. becoming *a critical actor* who can

exploit virtual experiences in order to increase his or her cultural, social and even economic capital. Because of its potential to develop critical attitudes and skills, interactive storytelling can play an important role in relationship to this form of digital inclusion.

- *Evaluation*. While a number of evaluation methods exist that address interactive technology in relationship to children (see Markopoulos et al., 2008), there is a lack of methodological tools to assess systems, artifacts and processes in the specific context of children's storytelling. In particular, we need to achieve a better understanding on aspects related to the value of children's storytelling tools and activities, on who decides what is beneficial and for whom, and how to identify short term vs. long-term benefits.

Finally, our survey pinpoints that, presently, ISC is very much at a crossroads, a meeting place of several research disciplines (IDS and IDC in particular), and not yet a comprehensive field. It continues to exist at the border or as a sub-branch of other disciplines, in particular IDS or IDC. There is limited body of dedicated theory which takes into account the peculiarity of the interactive storytelling process in relationship to children. In addition, there is an oftentimes inconsistent use of terminology and a tendency of calling on other research fields for either theoretical backup, or definition of terms, very much depending on the approach and background of the researchers. Addressing these issues represent a crucial theoretical and methodological challenge.

Yet, the richness of current results and research efforts in ISC highlighted in this paper allows us to argue that, despite the above limitations and the evident relatedness with other fields, ISC has the potential to become a coherent and autonomous discipline in its own.

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