Interactive technologies that enhance children's creativity

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ABSTRACT
Creativity and imagination play a key role in human learning and development. This workshop aims at promoting the discussion on interactive technologies that enhance children's creativity. Questions of interest include, but are not limited to: what is creativity in the first place, and how to design, develop and evaluate technologies that enrich children's expressive power, as well as their abilities to think "laterally" (out of the box). We seek contribution on the design of tools that encourage young people to explore differently their environment, to capture their experience of the world, to crystallize and transform these occurrences in a creative way.

Categories and Subject Descriptors
H5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous

General Terms
Design, Experimentation, Human Factors, Theory.

Keywords
Creativity, Interaction design, Children.

1. INTRODUCTION
Most educators would agree that creativity and imagination play a key role in human learning. And yet, as children grow older, they enjoy less and less opportunities— at least in classroom settings— to "unleash" their imagination, to bring to life their wildest dreams, and to put at the service of their intelligence their natural abilities to envision and play out alternatives in their minds. Fair enough, the children may go to art classes, and the arts start to be included in STEM programs (STE[A]M: Science, technology, engineering, [arts], and mathematics). Yet it is difficult not to trivialize the sciences or the arts when one introduces creativity to learning. Along with Vygotsky [14], we think that imagination is present in all aspects of the cultural life and makes the artistic, scientific and technical creativity possible. Vygotsky defined the mechanisms of imagination and creativity as the experience and the re- elaboration of experience through disassociation, association and mutation.

This workshop aims at promoting the discussion on interactive technologies that enhance children's creativity. Questions of interest include, but are not limited to: what is creativity in the first place, and how to design, develop and evaluate technologies that enrich children's expressive power, as well as their abilities to think "laterally" (out of the box). We seek contribution on the design of tools that encourage young people to explore differently their environment, to capture their experience of the world, to crystallize and transform these occurrences in a creative way.

Contributions can be theoretical, methodological, technological, and practical, in particular discussing case studies that rely on creativity targeting children.

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1.1 State of the art on creativity at a glance
Before becoming an object of scientific inquiry and experimental studies in psychology, creativity was apprehended in various ways. Some historical references are here relevant [8]. In ancient Greece, creativity was initially considered in a mystical way where inspiration was attributed to a non-rational source (a muse that inspires or being under the influence of a spirit [8]). Later on, and as a counter-point Aristote claimed that inspiration finds its source inside the individual, through mental associations. Then, around the 18st century, the subject of creativity came back to the centre of philosophical debates, with a focus on the creative genius and talent resulting from an innate ability to produce and combine ideas [8]. Still later, these reflections led several authors to question the nature of creativity, the traits of personalities promoting its emergence as well as the psychological functioning of subjects considered as creative. All this is done for trying to assess and measure it (through scales of intelligence or creative writing case studies). Later, other studies will point out the role of the unconscious, emotion and intelligence in creative thinking [8].

Understanding the historical evolution of creativity is a necessary prerequisite to understanding, on the one hand, how it became an object of study for science, and on the other hand, understand how the underlying epistemology will decisively guide its analysis (whole paragraph seems redundant. Or should be placed before.

Cognitive processes, personality, and cultural influences are all factors that have been investigated in order to understand creativity [1, 13]. . Several components have been identified along these axes: in particular: motivational issues, knowledge, skills, and processes related to creativity as a cognitive style [8]. Other aspects include cognitive factors (intelligence, knowledge), conative factors (style, personality, motivation), as well as emotional and environmental factors. Thus, creativity is considered as the result of a complex interaction between various components [8]

Studying creativity raises many questions that need clarification : how can we define and describe creativity? And define its role in a person's or group's cognitive, and emotional development? How to assess or measure creativity ? it is measurable in the first place? [8].

A widely agreed-upon definition of creativity has been proposed *: "creativity is the ability to achieve a production that is both new and adapted to the context in which it is manifested"* [2, 8]. This production may be a story, a drawing... This definition puts forward several elements: the unique character and unexpected production or the fact that creativity respond to a particular context such as overcoming a difficulty or a need to satisfy. According to this definition, creativity is defined as an individual ability which improves a given task

However, as discussed by Lahoual et al. [7], this definition becomes problematic if we attempt to investigate the creativity with children in the context of specific tasks in educational situations (e.g. writing a story, playing). How can we identify creativity if these activities do not meet the defined criteria ? In the absence of these criteria (novelty, overcoming a difficulty and responding to a specific need), could we still define a production as creative? Rouquette has conducted further work on the question [12], he concludes that creativity is "*an attribute issued socially in special circumstances for singling out a product"*. Here, the value of creation does not matter, it is the legitimacy attributed to the Creator, which becomes decisive. Rouquette insists on the impossibility of scientifically studying the creative process if the latter is assessed and rated subjectively by judges, themselves involved in a social, economic and political role play.

Grounded in the socio-cultural perspective, and in the work of Vygotsky [14] , another vision of creativity emerges : creativity should not be considered as a frozen activity (what does "frozen activity" mean here? Do you mean "innate talent?), and is not the prerogative of geniuses. Instead, it is a learned process of playful (and mindful) engagement and "oblique" expressivity that is accessible to anyone. The Russian psychologist stresses the importance of imagination – a mental function at the basis of creativity - in child development and in all cultural aspects of life. He defines creativity as any human act that could give " *birth to something new (...) whether it is a physical object or a mental or emotional construction* " (2004/1967).

To Vygotsky, the creative activity of the imagination belongs to all, to the man in the street, to the technician. Essential to the scientific discoveries, to the work of art, it is also a necessary condition of the everyday life. The imagination is an instrument of the mind, it serves to play, to work, to live.

Vygotsky identifies four types of relationships that combine reality and imagination: at first, imagination feeds off materials from reality, thanks to the richness and variety of the child experiences. Furthermore, social relationships enrich the imagination through the sharing of experiences with other peers. Emotions also influence imagination that seems in turn to affect our sensations, our moods and our emotions. And finally, the last relationship between reality and imagination is consolidated when it is embodied in external and shareable physical objects. Vygotsky also stresses that creativity plays an important role in child develoment. It allows the child to transform his experiences and impressions in order to build a new "reality" that meets his needs and desires [14]. Creativity involves the abilities to change perspectives, adopt another point of view and think different possibilities (what if?), all of which contribute to a richer and more complex vision of reality. Creativity reveals the implementation of individual dynamic processes with collective and cooperative dimensions when children exchange between them.

In [11] Resnick argues that in today's rapidly changing world, creative solutions must be worked out by people in order to face unexpected problems. The ability to think and act creatively will become a key element in what he calls a « Creative Society ». Unfortunately, education does not always help children to become creative thinker!. At school students mostly learn to solve specific problems, but they do not learn to improvise in response to unexpected situations. Resnick argues that technologies can play a key role in the « Creative Society ». 1) With the proliferation of digital technologies, the pace of change is quickened, which in turn accentuates the need for creative thinking 2) If properly designed and used, technologies can contribute to the development of people as creative thinkers. The kinds of technologies proposed by Resnick and his group at the MIT Media Lab (Crickets and Scratch) are designed to help children in becoming creative thinkers.

2. CONTRIBUTIONS FROM THE SELECTED SUBMISSIONS

From the received submissions we selected 14 excellent papers for being presented at the workshop (see http://itecc.paragraphe.info/ for online versions of the papers). We selected the most intriguing, interesting and relevant work that could exemplify the main tendencies in research in the field.

The contributions explore the domain of creativity and provide a diversity of perspectives along multiple dimensions.

2.1 Definition and approaches of creativity

Selected papers offer different definitions of – and approaches to - creativity. Some authors ground their work in a socio-cultural perspective [14], including Lahoual & al. ; Chu ; Giannakos & al.; De Souza & al; Rizzo & al. Others seem to adopt a more explicitely constructionnist perspective, in particular Manches, Kynigos, El Zanfaly, Shafer & al.

The paper by Lahoual, Decortis, & Bationo-Tillon "*A dynamic and situated approach in creativity – From analysis to modeling*" offers a theoretical perspective on modeling creative process. Authors discuss two models [3, 4, 5 and 10] and how these models contribute to analyze children activity and to design tools that sustain creativity. Finally, they provide insights coming from case studies conducted at the Centre Pompidou in Paris.

In his paper "Digital technologies and creativity in early mathematics and science," Manches adopts a definition of creativity proposed by the National Advisory Committee for Cultural and Creative Education : *"Imaginative activity fashioned so as to produce outcomes that are both original and of value"*. This definition reflects a concern for novelty and value, yet adds that both 'originality' and 'value' should be considered relative to the learner's own context.

2.2 Creativity *in situ*

Some contributions explore creativity in the context of specific activities such as play, reading or storytelling.

The paper by L. De Valk, T. Bekker, B. Eggen "*Creativity and Play: Designing for Improvisation with Interactive Play Objects*" focuses on the design of interactive objects to support creativity. The authors are interested in the articulations between creativity and play, and discuss the importance of improvisional, or open-ended, play : in improvisation children use their imagination while playing, they create their own games and rules. This concept has been deployed in the design of a open-ended interactive play environment called Wobble.

In the paper, "*An Enactment-Based Approach to Creativity Support*", S. Chu presents a model of the "mediated creative

process". The authors argue that the design of enactment based technology supports creativity in childen. In the line of previous research and development [4, 6], they use the foundational vygotskian theory to understand the active process of a child's narrative as a means to inform the design of creative support technologies. A case study is described, in which the model is used to build an application and assess her initial hypothesis. How multimedia interfaces encourage the use of micro-enactment to support broader imagination of the child is also addressed in the paper.

Michail N. Giannakos et al., in their paper "*Our Toys: Towards an Enriched Artifacts Activity for Supporting Creative Learning*", present their experience in organizing a workshop program namely "Our Toys" in which pupils play with open source software and hardware assisted by artist and HCI researchers. They provide evidences on the value of the workshop activities in stimulating children creativity.

Rizzo, E. Rubegni, M. Caporali in their paper "*Sillaby: learning to read in a creative way*" evaluate an application to support reading in a creative way. The application is based on engaging children in a multi-sensorial experience to create an impact on learning how to read. They run a study with parents and young children.

In these papers, creativity is a way to realize a main activity. Through case studies, we understand that creativity has an effect on the shape of the main activity: more motivated, children realize these activities with more pleasure.

2.3 Creativity in formal and informal education environments

Two types of contributions relate to formal and informal educational environments.

In "*AR-based chemistry learning with mobile molecules* ", A. Ducao, C. Milne, I. Koen, present a very interesting work on using art to support chemistry concepts learning. The system and its possible value of tangible for learning is explained.

In their paper, K. I. De Souza and R. Garcia Fernandez "*Animation to enhance knowledge construction and creativity in educational processes: collaborative activities developed at schools in Brazil*", describe a project conducted in a primary school in Brasil for children 5-6 years old. The focus of the project is on pedagogy to develop knowledge construction in "collaborative educational spaces" to promote dialogue between schools actors. Their researches are based on qualitative approach including participatory observation in urban environments.

K Konygis and F. Moustaki, in their paper, "*Designing tools to support group work skills for constructionist mathematical meaning generation",* address the co-construction of meaning through collaboration in groups. The aim is to help pupils to learn to learn together. Pupils are invited to create several shapes, which can have a status of boundary objects in order to negociate and co-construct meaning.

In the paper "*Digital Technologies and creativity in early mathematics and science*", A. Manches presents a very interesting work on the role of creativity in science and math for young children (3-8 years old) and implications for design. Two keys aspects of creativity are analyzed, generating and evaluating ideas. Emerging forms of interaction offers new opportunities to foster children's ideas. Several dimensions emerges for design: one is related to space, the extend to which designs offer space to generate ideas.

D. El Zanfaly, in the paper "*Democratizing design by making: A Case study in Egypt"*, describes an interesting case study on a Fab-lab workshop. She explores the benefits of introducing machines to children in order to enhance their development. She argues that when children learn how to think with artifacts such as electronics, drawing, when they learn by doing, they learn in a creative way and this could be sustain by technology. The sensory experience is here also part of the game and the author explores a workshop conducted at Fab Lab Egypt.

These papers underline the importance of collaboration all along the activity and invite us to discuss the importance of negotiation, collaboration and materiality in creativity.

2.4 Challenges of designing for creativity

To conclude, some papers propose technical devices to enhance creativity in design process, related to children drawing and reading.

The paper by Walsh *"Online Design Team: Developing an Interactive Environment that Supports Distributed, Intergenerational Participatory Design*" describes a study based on an online intergenerational (children and adults) co-design activity. Their approach enables pupils to generate ideas, express themselves and share these concepts among the others.

M. Lew, in his paper *"Designing a collaborative tabletop interface that animates children's drawings***",** presents a device which animate children drawings.

The paper by G. Schafer, K. Green and al. « *Desiging the LIT KIT, an interactive, cyber-physical artefact enhancing children's picture-book reading*" is about a kit for allowing children creating an environment for supporting interactive reading aloud.

These papers are interesting contributions that raise questions about a more technical versus child design process, and offers the opportunity to discuss the relevance of a multidisciplinary approach, to confront technical point of view vs human point of view, to identify convergences and divergences of both of them. For example, some crucial questions might surely emerged : How to allocate tasks between technical device and human activity in order to enhance children creativity ? Which tasks can be automated and supported by technical tools ? Which tasks can be supported by children in order to enhance creativity ?

3. DISCUSSION AND WORKSHOP SETTING

Defining creativity is not an easy matter as we see. In the workshop our aim is to open the discussion on this matter. Some authors envisions creativity as it fits in a social constructivist approach. They study creative process in situations by taking into account the social sphere, where interactions and exchanges are important as the point of view of the subject. In this perspective, creativity is seen as a constructive process that serves a finalized activity such as the production of ideas or physical objects. This creative process is further enhanced when the subject actively draws on materials in reality and his experiences (when he is interacting with environment and other individuals) to feed creativity. But every authors do not share this perspective.

In the first part of the workshop authors will make a short presentation of their papers (5 min ca.). Afterwards, in order to explore the different topics discussed in the papers, attendees will be grouped in teams (up to 5 each) and they will elaborate some of these issues through brainstorming activity. These sessions will

be short (45 min ca.) and iterative in order to trigger discussion among participants and to pinpoint several problems. Brainstorming is a well-known method for creative problem solving and it is used in the design community for the development of innovative concept. Finally brainstorming helps to break the rules of logic reasoning and to favor critical and lateral thinking. This process will allow participants to creatively discuss about the main topics emerged form the papers and to contribute to create a research agenda about designing and evaluating interactive technologies that enhance children's creativity. Our final objective is to exploit the workshop in the direction of identifying theoretical approaches, methodologies and research questions that are more promising to pursue for the future. At the end of the workshop the objective is to have highlighted the main issue regarding this topic as well as to create a research agenda relevant for the field.

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