Proceedings of IDC2010

IDC 2010

The 9th International Conference on Interaction Design and Children

BARCELONA, Spain - June 9-12, 2010

Conference Chairs:
Narcís Parés
Miquel Olivé
Universitat Pompeu Fabra
Barcelona, Spain

ISBN: 978-1-60558-951-0

Notice to Past Authors of ACM-Published Articles

ACM intends to create a complete electronic archive of all articles and/or other material previously published by ACM. If you have written a work that was previously published by ACM in any journal or conference proceedings prior to 1978, or any SIG Newsletter at any time, and you do NOT want this work to appear in the ACM Digital Library, please inform permissions@acm.org, stating the title of the work, the author(s), and where and when published.

About ACM

ACM is an educational and scientific society uniting the world's computing educators, researchers and professionals to inspire dialogue, share resources and address the field's challenges. ACM strengthens the profession's collective voice through strong leadership, promotion of the highest standards, and recognition of technical excellence. ACM supports the professional growth of its members by providing opportunities for life-long learning, career development, and professional networking.

ACM was established in 1947 with the creation of the first stored-program digital computer and today carries out its mission through conferences, publications, educational programs, public awareness activities, and special interest groups. It sponsors over 120 conferences annually and its more than 82,000 members come from industry, academia and government institutions around the world. ACM hosts the computing industry's leading Digital Library and Guide to Computing Literature, and serves its global members and the computing profession with journals and magazines, conferences, workshops, electronic forums, and Online Books and Courses. The A.M. Turing Award, presented yearly by ACM, is regarded as the "Nobel Prize of computing."

IDC 2010 builds on the successes and high standards of the previous IDC conferences: IDC 2009 in Como, Italy; IDC 2008 in Chicago, USA; IDC 2007 in Aalborg, Denmark; IDC 2006 in Tampere, Finland; IDC 2005 in Boulder, USA; IDC 2004 in Maryland, USA; IDC 2003 in Preston, UK; and IDC 2002 in Eindhoven, the Netherlands.

IDC 2010 was organized in cooperation with:

Association for Computing Machinery
SIGCHI
IFIP TC13 Special Interest Group on Interaction Design for Children
Social Projects "la Caixa" Foundation

Organized by:

Universitat Pompeu Fabra
Audiovisual University Institute (IUA)
Department of Communication
Department of Information and Communications Technologies

With the support of:

Gobierno de España
Ministerio de Ciencia e Innovación

FOREWORD

As in previous editions of IDC, the general goals of the 2010 conference have been to better understand children's needs, and how to design for them, by presenting and discussing the most innovative research in the field of interaction design for children, by exhibiting the most recent developments in design and design methodologies, and by gathering the leading minds in the field of interaction design for children.

In this specific edition we would like to especially promote the field of **full-body interaction**. According to health organizations, the current generations of children in the developed world will be the first to have a decrease in life expectancy with respect to our generation of middle-aged adults. The European Commission is especially worried about the rate of incidence of this lack of physical activity in European countries and is already defining policies and actions to try to compensate for this public health issue. Moreover, this lack of physical activity also carries the collateral effect of lack of social activity.

Some studies by the WHO have concluded that one of the main causes for this lack of physical activity is the intensive use of video-games and consoles, the Internet, chats, social networks, etc. This does not mean these technologies are unhealthy for our children per se, but uncontrolled use of these can lead to unhealthy sedentary lifestyles. On the other hand, it would be absolutely unreasonable to define policies to ban these technologies from our children being already a very important part of their culture.

It is therefore one of the duties of our interaction design and children community to find solutions that compensate for this lack of physical and social activity. Full-body, or embodied, interaction may be one solution by finding ways to converge interactive technologies with full-body activity from, for example, playground structures, sports, etc.; or by defining completely new full-body interactive experiences that may promote physical activity in our children while allowing them to play with their contemporary media.

Therefore, the very specific topic we have proposed to emphasize in IDC2010 has been:

"Full-body Interaction for Children.
To enhance physical, mental and social well-being of Children"

In other words, to propose interactive experiences that are conceived for full-body action. The difference of attitude, activities, socialization potential, collaboration opportunities, physical exercise, etc., that such interactive experiences provide with respect to desktop applications make them well worth the interest they generate. However, this is a somewhat unexplored field and it is important to give it a drive forward. Hopefully we will obtain healthier experiences for children through interactive media.

IDC is growing with every new edition proving its interest within the HCI community and especially in those researchers working specifically with children. This year we have received contributions from all continents that compose the present compendium of works.

Dr. Narcís Parés Burguès
Universitat Pompeu Fabra, Barcelona, Spain

Table of Contents

COMMITEES

Conference co-Chairs

- Narcís Parés, Universitat Pompeu Fabra
- Miquel Oliver, Universitat Pompeu Fabra

Papers co-Chairs

- Janet Read, U. of Lancashire
- Tom Moher, University of Illinois at Chicago

Short Papers (Posters) co-Chairs

- Maria Roussou, makebelieve design & consulting
- Susanne Seitinger, Smart Cities/MIT Media Laboratory

Demos co-Chairs

- Paul Marshall, The Open University
- Sergi Jordà, Music Technology Group, Universitat Pompeu Fabra

Workshops co-Chairs

- Mari Carmen Marcos, Universitat Pompeu Fabra
- Svetlana Yarosh, Georgia Institute of Technology

Doctoral Consortium

- Edith Ackermann, Massachusetts Institute of Technology, USA
- Michael Eisenberg, University of Colorado at Boulder, USA

Local Organising Committee

- Irene Da Rocha, Universitat Pompeu Fabra – Local Arrangements
- J. Ignasi Ribas, Universitat Pompeu Fabra – Local Arrangements
- Carles Sora, Universitat Pompeu Fabra – Local Arrangements
- Ernesto Arroyo, Universitat Pompeu Fabra – Program
- Joana Clotet, Universitat Pompeu Fabra - Secretariat
- Joan Soler-Adillon, Universitat Pompeu Fabra - Volunteers
- Mònica Figueras, Universitat Pompeu Fabra - Media
- Eduard Sellabona, Universitat Pompeu Fabra – Graphics design and Web Master

Program Committee

- Alissa Antle, Simon Fraser University, Canada
- Nikolaos Avouris, University of Patras, Greece
- Sebastiano Bagnara, University of Sassari at Alghero, Italy
- Tilde Bekker, Eindhoven University of Technology, The Netherlands
- Paolo Blikstein, Stanford University
- Davide Bolchini, Indiana University, USA
- Paul Brna, University of Edinburgh, United Kingdom
- Hester Bruikman, University of Eindhoven, The Netherlands
- Winslow Burleson, Arizona State University, USA
- Antonio Camurri, University of Genova, Italy
- Lorenzo Cantoni, Universita' di Lugano, Switzerland
- Amanda Carr, Roehampton University, United Kingdom
- Stefano Cerri, LIRMM-University of Montpellier, France
- Daniel Churchill, University of Hong Kong, Hong Kong
- Antonella De Angeli, The University of Manchester, United Kingdom
- Diego Diaz, Universitat Jaume I, Castelló, Spain
- Paloma Diaz, Universidad Carlos III de Madrid, Spain
- Yannis Dimitriadis, University of Valladolid, Spain
- Allison Druin, University of Maryland, USA
- Paolo Ferri, Universita di Milano-Bicocca, Italy
- Panos Markopoulos, Eindhoven University of Technology
- Franca Garzotto, Politecnico di Milano, Italy
- Helene Gelderblom, UNISA, South Africa
- Shuli Gilutz, Columbia University, USA
- Toni Granollers, Universitat de Lleida, Spain
- Mark D Gross, Carnegie-Mellon University, USA

- Mona Leigh Guha, University of Maryland, USA
- Juan Pablo Hourcade, University of Iowa, USA
- Ole Sejer Iversen, University of Aarhus, Denmark
- Stine Liv Johansen, University of Aarhus, Denmark
- Joel Josephson, Kindersite Project, United Kingdom
- Yasmin Kafai, University of Pennsylvania, USA
- Matthew Kam, Carnegie Mellon University. USA
- Nancy Kaplan, University of Baltimore, USA
- Helle Karoff, University of Aarhus, Denmark
- Caitlin Kelleher, Washington University in St. Louis, USA
- Gerhard Kraetzschmar University of Applied Sciences Bonn-Rhein-Sieg, Germany
- Chronis Kynigos, University of Athens, Greece
- Jean-Baptiste Labrune,MIT Media Laboratory
- Rose Luckin, London Knowledge Lab, United Kingdom
- Leilah Lyons, University of Illinois at Chicago, USA
- Patrizia Marti, University of Siena, Italy
- Yishay Mor, London Knowledge Lab, United Kingdom
- Eva Petersson, Aalborg University Denmark
- Sara Price, London Knowledge Lab, United Kingdom
- Chris Quintana, University of Michigan, USA
- Roope Raisamo, University of Tampere, Finland
- Alexander Repenning, University of Colorado, USA
- Glenda Revelle, Sesame Workshop, USA
- Jochen Rick, The Open University, United Kingdom
- Antonio Rizzo, Universita' di Siena, Italy
- Judy Robertson, Heriot-Watt University, United Kingdom
- Yvonne Rogers, The Open University, United Kingdom
- Teresa Roselli, University of Bari, Italy
- Elisa Rubegni, Universita' di Lugano,Switzerland
- Demetrios Sampson, University of Piraeus & CERTH, Greece
- Corina Sas, Lancaster University, United Kingdom
- Sergio Sayago, Universitat Pompeu Fabra, Spain
- Heidi Schelhowe, University of Bremen, Germany
- Ayelet Segal, Columbia University, USA
- Robert Sheehan, The University of Auckland, New Zealand
- Bill Shribman, WGBH Educational Foundation, USA
- Mikael Skov, Aalborg University, Denmark
- Masanori Sugimoto University of Tokyo, Japan
- Deborah Tatar, Virginia Polytechnic Institute and State University, USA
- Martin Tomitsch, University of Sydney
- Veronika Vanden Abeele, GroepT Leuven CUO, Belgium
- Thomas Winkler, University of Luebeck, Germany
- Niall Winters, London Knowledge Lab, United Kingdom
- Karsten D. Wolf, University of Bremen, Germany
- Mariko Yamaguchi, The Johns Hopkins University, USA
- Susan Yoon, University of Pennsylvania, USA
- Bieke Zaman, Katholieke Universiteit Leuven, Belgium
- Oren Zuckerman, IDC Herzliya, Israel
- Rowanne Fleck, University of Sussex, United Kingdom

.

KEYNOTE

Dr. Mark Mine
Director of the Creative Technology Group, Walt Disney Imagineering

June 10, 2010 - Co-organized with "la Caixa" Foundation and held at CosmoCaixa Science Museum

"The Magic of Interactive Experiences for Children: The Walt Disney Imagineering Approach"

Abstract

Ever since Walt Disney first opened the doors to Disneyland in 1955, Imagineers have been using (and misusing) state-of-the-art technology to immerse their guests in magical worlds. Combined with richly detailed environments, imaginative characters, and compelling stories, these tools have enabled visitors to Disney theme parks to dance with ghosts, sail with pirates, and fly to the furthest reaches of both inner and outer space.

The theme park world of today, however, is vastly different from the theme park world of 1955; audiences are more diverse, guests more sophisticated, and children growing up faster than ever before. The competition is likewise greater than ever before; consumers have an increasingly broad array of rich and compelling entertainment options to choose from, many conveniently located in the local theater, shopping mall, and more than ever in the home. To succeed in this ever-changing marketplace, Imagineers must continue to innovate and push the boundaries of engineering, design, and magic. Our worlds must be richer, our characters more interactive, and our storytelling more fluid, customizable, and reactive.

In this talk, Mark will describe the new techniques and technology Imagineers are using to light, animate, and augment Disney theme parks. He will describe the tools being used to bring the world of Disney animated features to life in ways never before possible. He will relate how Imagineers are using advanced sensing technology and better awareness of their guests to create smart reactive environments and new forms of entertainment. He will present advances in Animatronic characters that make them more responsive, aware, and engaging. He will discuss the challenge of designing for audiences with diverse backgrounds, skill sets, and ages. He will show how all of these efforts are bound together by the goal of creating fantastic worlds of magic and imagination for Disney guests around the world.

Bio

Currently in his 12th year with Walt Disney Imagineering, Mark Mine is the Director of the Creative Technology Group. The fundamental mission of the Creative Technology Group is to help Imagineering's creative and engineering teams build better theme park rides and attractions through new ways to design, evaluate, and present innovative concepts and ideas. This includes the development and integration of real-time and pre-rendered computer graphics technologies and techniques into the blue sky design process.

Mine began his Disney career in 1997 in the Virtual Reality Studio, as a programmer/designer for interactive attractions in the DisneyQuest virtual theme park project. Since then, he has worked on attractions such as Mission: SPACE, Finding Nemo Submarine Voyage and Toy Story Mania!

Prior to Disney, Mine worked as an engineer for the Jet Propulsion Laboratory on projects such as the Voyager Spacecraft. Mine has a bachelor's degree in Aerospace Engineering from the University of Michigan, a Master's degree in Electrical Engineering from the University of Southern California, and a Master's degree and Ph.D. in Computer Science from the University of North Carolina..

PANEL

A Manifesto for Interaction Design and Children

PANEL: Chair Janet C Read

Participants:

Interaction design is a relatively new field that takes its inspiration and methods from many research areas including human computer interaction, industrial and product design, media design, software engineering, architecture, craft studies and psychology. As a result of this mixture of approaches, interaction design suffers from, and is also enhanced by, variations in interpretation and uncertainties about the relative values of the products that are developed under its auspices.

Interaction design for children is a discipline that also has to take account of the specific needs of children across different ages and in varying contexts. Designers have to also take account of additional stakeholders (generally adults) when designing for children who may typically be gatekeepers or providers of technology products.

The interaction design for children (IDC) community has a pivotal role in the definition of what comprises good interaction design for children. In accepting papers for publication, in promoting demonstrations of technologies and in acknowledging experts and innovators in the field, the IDC community has a responsibility to behave in the best interests of both the researchers it supports and, perhaps more importantly, the children it champions.

This responsibility brings with it challenges. It is often the case that a single research contribution fails to meet the needs of researchers and children equally. Work that is technologically innovative may be poorly situated in context, work that is very child cantered may offer nothing new to the research platform, work that is complex and interactive may be badly designed. Whilst a product might be highly interactive in a novel way, if that same product was considered to be too expensive for 99% of the world's children, or if the product was designed for an environment where it was patently unsuitable, should that work be brought to the table? In short, the IDC community faces difficult choices when endorsing interaction design work.

In this panel we will explore these challenges. We will highlight key concerns including sustainability, design for the context, persuasiveness, costs of technologies and dividedness and will aim to develop, during the discussion a "Manifesto for Interaction Design and Children" that clearly states our position on the types of interaction design research and on the interaction design products that the community considers to be desirable.

The "Manifesto for Interaction Design and Children" will put the IDC community ahead of the game in defining what it is to do good (in the broadest sense) interaction design work. The manifesto will be used in future IDC conferences to drive research and development - it will be the benchmark against which submissions to the conference are measured and it will give our conference a peer defined quality bar.

IDC2010 FULL PAPERS

IDC2010 SHORT PAPERS (POSTERS)

Exploring rules and underlying concepts while engaged with collaborative full-body games

Chronis Kynigos & Zacharoula Smyrnaiou
Educational Technology Lab, School of Philosophy, N.K. University of Athens
Ilissia 15784, Athens, Greece
+30 2107277508
kynigos@ppp.uoa.gr, zsmyrnaiou@ppp.uoa.gr

Maria Roussou
Makebelieve design & consulting
H. Attikou 10 Maroussi,
15124 Athens, Greece
+30 6977325456
maria@makebelieve.gr

ABSTRACT
In this paper, we describe the theoretical background, educational design and preliminary evaluation of children's interactions with a set of collaborative full-body digital games, which are set in an informal science education fun park, the Polymechanon. Twelve 10-year olds were observed while interacting in groups with the games, and two of the games were studied closely by interviewing the children. Results indicate that children perceive the rules of the games and the underlying concepts in different ways and the longer they play the more their verbal interactions change from actions-centred to concept-centred.

Categories and Subject Descriptors
H5.m. [**Information Interfaces and Presentation (e.g., HCI)**]: Polymechanon. K.3.0 [**Computers and Education**] : General.

General Terms
Design, Human Factors, Experimentation

Keywords
Full-body interaction, embodied schemas and metaphors, gestural interfaces, informal education, learning.

INTRODUCTION
In this paper we introduce the idea of collaborative full body games for learning. The games are set in a new interactive educational gaming centre in Athens, Greece called *Polymechanon* http://polymechanon.gr, an informal learning endeavour stemming from the Educational Technology Lab of the School of Philosophy, University of Athens. They are based on bodily shadow, weight and position recognition and involve groups of players (3 to 12 in number, depending on the game) interacting with digital representations on large projection surfaces.

The Polymechanon center has eleven such collaborative games based on human control of and interaction with digital and mechanical technologies. In designing the games, we perceived bodily movement as an inherent means with which humans express meaning along with gesture, language and static and dynamic semantic representations.

Within mathematics and science education, there have been attempts to address body, motion and sense as integral means with which humans express thoughts and meanings [6]. The question that we asked at the outset was how to employ such frameworks to approach the design of interfaces for learning, by addressing all these means for human expression in a holistic way. Several experiments have been conducted on how children learn as they use dynamic representations in digital simulations to express mathematical [5] and scientific meanings [3]. There have also been interesting approaches to children's use of gesture and to kinesthetic interfaces (e.g. [2], [7] and [8]) where manipulating and moving tangible artifacts affects digital representations.

The learning games discussed here require children to collaborate / negotiate while they move about and to make gestures in order to interact with the digital medium and play the game. In studying how children play these collaborative full-body games, we were interested in understanding what meanings they developed through body-movement, gesture, language and interaction with the games' digital representations and how these meanings related to the mathematical and science meanings embedded in the games.

DESIGNING INTERACTIVE LEARNING ENVIRONMENTS BASED ON EMBODIED THEORY
The idea that embodied interaction influences thought and learning is not new. More recently, studies in education address the benefits of learning environments designed to incorporate embodied interaction in children's learning processes (e.g. [7] and [8]). Researchers assert that gestures and body language not only reveal aspects of learning processes but can also help children learn in special ways.

In embodied learning, the cognitive comprehension of mathematical or scientific concepts produces complex dynamic activities (bodily actions, gestures, handling of materials or design, planning) and the kinesthetic activities play a significant role. The conceptual metaphors appear as if they are based in a basic and innate cognitive mechanism that is activated for the construction of concepts. Via these embodied cognitive mechanisms, the inductive drawings that emanate from the experience can be extended in very concrete and precise ways and give reason for new resulting inductive organization in more abstract sectors [6].

This new theoretical dimension of embodied theory has influenced human-computer interaction (HCI) and the design of technological environments and objects. In terms of game design principles, the interactive environments we sought to create would ideally synthesize important elements of an entertainment experience, in other words, intrinsically and extrinsically enjoyable and motivating interaction techniques. In terms of the collaborative qualities of the learning experience, the interfaces should allow the opportunity to work with others to promote interactive learning in a social environment, but also to compare skills to those of other users'. Finally, in terms of the learning content, the design of the games were influenced by the learning object i.e., math and science (e.g. [4] and [5]). Despite the plethora of research projects, attempts to incorporate embodied interaction practices in educational environments have been scarce [1].

The idea behind the Polymechanon has been to put into practice the aforementioned research theories, thus forming an innovative testbed for exploring and studying, in a practical real-world setting, this natural form of full-body interaction for learning. In the remaining sections of this paper we describe the study that we carried out to explore the effectiveness of our approach.

THE 'SORTER' AND 'WOBBLE BOARD' GAMES

In order to study the effect of embodied interaction for learning in the informal educational context, we chose to focus on two of the interactive games installed in the Polymechanon.

The 'Sorter' game[1] is one of four full-body games based on shadow recognition. The players -their body contours projected on a screen as shadows- have to quickly decide for each object that "falls" down from the top of the screen, which base it belongs to and move it so that it drops on that base. The objects are geometrical shapes, categorized according to their properties (regular polygons, irregular shapes, curved shapes).

[1] Adapted from the Sorter game that was originally designed and developed by Feedtank, www.feedtank.com, in collaboration with *makebelieve design*, www.makebelieve.gr.

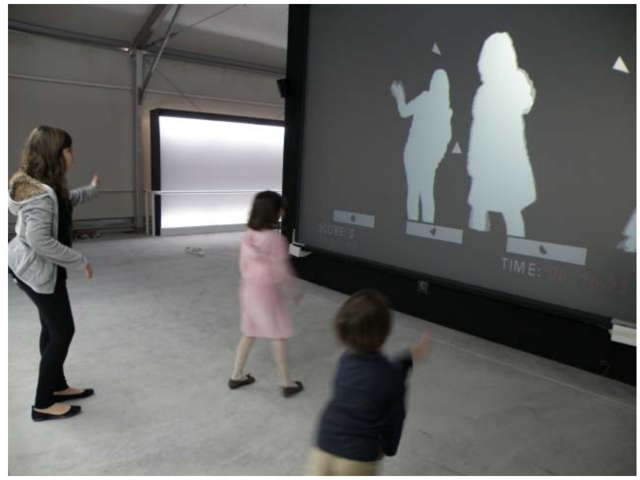

Figure 1. Children playing the 'Sorter' game.

The 'Wobble board' game[2] involves the interaction between the composite weight on a 5x5 meter floor and a virtual board balancing on its centre (Figure 2). Up to twelve players need to collaboratively move on the floor board so as to move the virtual board accordingly; the goal is to displace a number of balls so that they drop into a number of fixed holes on the virtual floor. In order to do that they need to negotiate how they will move themselves on the board. The ideas of forces, balance, weight, location and direction are embedded in the game which has various parameters such as simulated friction of the balls on the virtual floor, etc.

METHODOLOGY

This preliminary evaluation study was performed at the Polymechanon with primary school visitors, spread across the various exhibits in groups. We recruited a total of 12 children, aged ten. All children rotated in playing all of the full-body games in teams (including the ones not discussed here), while a team of three researchers participated in each data collection session, using video and audio recorders. Background data was also collected (e.g., students' worksheets and observational notes) and all recordings were analysed verbatim. Additionally, post-task interviews were conducted with all participants. No instructions were given to the players before or during their game playing experience.

DATA ANALYSIS

Even though all children played with all of the games, for the purpose of this study we limited our observations to children's playing, interactions, and responses concerning the two games described previously. The questions asked concerned children's understanding of the rules of the games, the tricks developed to win the games, communication mechanisms between players, and whether the games required thinking, movement or both. The specific analytical categories developed refer to Vergnaud's theory [10] who distinguishes three

[2] Co-designed and developed with *makebelieve design*.

functioning knowledge banks: a) the bank of actions performed; (b) the bank of mental representations and (c) the bank of symbolic representations. Based on this, a technology-based environment can facilitate the connection between these three knowledge banks and make it possible for the students to move from a phenomenologic representation (objects, manipulations performed, perceived events) to a representation in terms of physical concepts [9]. In this section we present responses to the first two questions.

Figure 2. The 'Wobble Board' installation.

Understanding the rules of the game

The goal of the question about the children's understanding of the rules of each game was to explore how the players interpret their activity and whether, ultimately, they can identify its underlying (educational) concept. For the Sorter game, children's responses were categorised as follows:

- 4 children described their actions phenomenologically, e.g., a child said that the idea of the game was 'to move your body and push the balls'.
- 1 child described the actions that they should not make, e.g., the child said: '1 main rule: you can't hold on to the bar in the back of you'.
- 3 children refer in their answers to the concept implicitly, e.g., 'the rules of the game were to move colors into the same color below'.
- 4 children mention in their answers the concept explicitly, e.g., 'the rules of the game were to sort the colors or shapes that were the same as the ones you were 'standing on'.

In other words, 41,6% of the children evoked their actions and 58,3% a concept incorporated in this interactive game.

For the Wobble Board game, the responses to the same question were categorised as follows:

- 6 children described their actions phenomenologically, e.g., a child said: 'we had to all work together to get the little ball into its hole''.
- 2 children described the rules as actions that they should not make, e.g., 'the rules of the game were not to run fast or stomp on the wood'.
- 2 children evoked in their answers the concept implicitly, e.g., 'the rules were about 5 people to get on the board and you had to go left, right, up, …'.
- 2 children evoked in their answers the concept explicitly (time, direction), e.g., 'the rules were to put the balls into the holes, we have limited time and I believe there were 4 stages. …'.
- 3 children emphasized in their answers the need to work as a team.

In other words, 56.6% of the children concentrated on their actions when articulating the rules of the game, 33.2% explained the rules as a concept that is incorporated in this interactive game, and 25% perceived the rules as a need to work as a team.

Devising techniques for gameplay

The children's responses to the question "What tricks did you develop to get more points?" for the Sorter game, were gathered in the following categories:

- 3 children described their method in relation to the position of their body (BO), e.g., one child said: 'I developed spreading like the letter V and when the things fell I would use one arm to pass the other'.
- 1 child's response explicitly referred to the group as the unit of play (TE), e.g., 'communicating with your teem mates (not yelling at one another)'.
- 2 children explicitly referred to the individual as the unit of play (IN), e.g., 'to take my color to my own color and my friends to their color'.
- 2 children referred to the number of players (NU), e.g., 'using more players'.
- 2 children developed a 'move and hit' trick (MH), e.g., 'I had to move all over the place so that if the color is going to the same color I don't hit it'.

Children developed different tactics to approach their interaction with the games. Three of the methods reported (TE, IN, and NU) were related to the collaborative nature of the game, while two (BO and MH) placed emphasis on embodiment. In the latter case, it seems that the movement and placement of the body were perceived by (41.6% of) the players as essential in achieving the goal. Whether, however, this can lead to deeper understanding of the underlying learning concepts requires further investigation.

The same question for the Wobble Board game yielded the following responses:

- 4 children related their trick to the group as a unit of play, implicitly or explicitly, e.g., 'So the key was cooperating'.
- 6 children related their trick, implicitly, to the underlying concepts of the game, e.g., 'we have to all be in one group'.

- 2 children related their method to the concepts of the game explicitly, e.g., 'each of us would go to one of the 4 corners and use our weight…'
- 2 children reported that the trick for best results related to the size of the group, e.g., 'The trick was to make 3 groups and if we have to go left and move down, 2 groups...'

In this case, 66.6% of children reported to the concept implicitly or explicitly and 33.2% of children emphasized the group -unit of play and size.

CONCLUSION

The purpose of the preliminary study described here has been to explore collaborative embodied interaction with computational representations as an integral part of expressing mathematical and scientific meaning in amongst the use of gestures and language. The 10 year-olds we observed in these collaborative activities with the two Polymechanon games seemed to perceive body motion as a natural way to interact with the games without this turning their attention away from the concepts and the need to negotiate about them. They seemed to directly connect their movement, gesture and communication with the concepts which they perceived as embedded in the games. Their activity incorporated identifying concepts and rules, developing problem solving techniques in order to score higher in the games, communicating about both concepts and potential solutions dynamically during play. This is not to say that they understood the concepts in a thorough or formal way, nor that they made connections with these concepts in other settings. This was not the focus or the scope of this particular study. In fact, the study points to the need for a lot more research into how pedagogical and interaction design techniques can enhance the probability that students may draw added value in understanding the concepts themselves. The evaluation of such multi-faceted interactive activity is a complex endeavour that cannot be exhausted in a small exploratory study such as this. Our goal with this study has been to explore how the children perceive the rules of the games and the underlying concepts as well as to guide us in the design of subsequent evaluations. In this sense, it is only the first step in a series of evaluation efforts with players of different ages and games of different kinds. It is also a first step in an exploratory process for identifying the kinds of authoring systems needed for educators and the types of design aids for interaction designers seeking to develop full-body game-based interactive learning. Nowadays, that sensor, light and position technologies are becoming easily accessible, the study of these issues becomes more pertinent than ever.

ACKNOWLEDGMENTS

We thank Costis Kontogiannis, Dimi C., George Technitis and John Manimanakis, and Dimitris Nastos for their contributions to designing and developing the games.

REFERENCES

1. Antle, A., Kynigos, C., Lyons, L., Marshall, P., Moher, T., and Roussou, M. 2009. Manifesting embodiment: Designer's Variations on a Theme. In Proceedings of CSCL (Rhodes, Greece), Panel, 15-17.
2. Arzarello, F., Robutti, O. 2003. Approaching Functions through Motion Experiments, in: Nemirowsky et al., Perceptuo-Motor Activity and Imagination, In Proceedings of Psychology of Mathematics Education (Honolulu, Hawaii, 2003), PME 27, 101-135.
3. Bakker, S., Antle, A.N., and van den Hoven, E. Identifying embodied metaphors in children's sound-action mappings. In Proceedings of Interaction Design for Children (IDC'09), ACM Press (Como, Italy), 140-149.
4. Eisenberg, M. and diBiase, J. 1996. Mathematical Manipulatives as Designed Artifacts: the Cognitive, Affective, and Technological Dimensions. In Proceedings of the International Conference on the Learning Sciences, Chicago, 44-51.
5. Kynigos, C. 2004. A Black and White Box Approach to User Empowerment with Component Computing, Interactive Learning Environments, Carfax Pubs, Taylor and Francis Group, Vol. 12, Nos. 1–2, 27–71.
6. Lakoff, G. & Núñez, R. 2000. Where Mathematics comes from, New York: Basic Books.
7. Marshall, P., Price, S., and Rogers, Y. 2003. Conceptualising tangibles to support learning. In Proceedings of the 2nd International Conference on Interaction Design and Children (Preston, England, June, 2003). IDC'03. ACM Press, New York, NY, 101-109. DOI= http://doi.acm.org/10.1145/953536.953551
8. O'Malley, C., and Stanton-Fraser, D. 2004. Literature review in learning with tangible technologies. Futurelab series, report 12.
9. Smyrnaiou, Z. & Weil-Barais, A. 2005. Évaluation cognitive d'un logiciel de modélisation auprès d'élèves de collège, Didaskalia, 27, 133-149.
10. Vergnaud, G. 1987. La fonction de l'action et de la symbolisation dans la formation des connaissances chez l'enfant, Psychologie, Paris : Encyclopédie de la Pléiade, Gallimard, 821-844.