Abstract

‘Future Designers’ is an interactive and participative crash course that aims to introduce to children the concepts and practice of creativity, design, and design thinking. The course targets multiple learning styles and intelligences, combining various learning approaches and tools, including lecturing (using a variety of media such as images, videos and music), creative question & answer, constructive – personal and collaborative – hands-on activities, play, humor and fun. The full course lasts 4-5 hours and can be delivered in a single or two sessions. This paper reports five pilot studies of the course, conducted over one year period with the objective of assessing the feasibility of the course and the attendees’ satisfaction, as well as obtaining feedback. The pilots took place as follows: in-house with 8 primary school teachers, 4 post graduate students and 2 children; in a real classroom with 22 children 10-12 years old; in a classroom environment with 25 primary school teachers assuming the role of children; in a school environment with 20 children 10-11 years old and their parents, as well as in a school environment with 27 older children (12-15 years old). The outcomes stemming from all pilots are very promising and indicate that ‘Future Designers’ is an engaging and fun experience for people of diverse ages, which can fruitfully engage children (but also adults) in creative activities, and can generate interesting design ideas.

1. Introduction

Design thinking represents both a way of thinking and a process that can foster creative thinking. In absolute terms, design thinking stands for all the cognitive processes that a person’s mind goes through when performing design. From a more practical point of view, Tim Brown, CEO of IDEO, has (re)defined design thinking as (Brown, 2008), “a discipline that uses the designer’s sensibility and methods to match people’s needs with what is technologically feasible and what a viable business strategy can convert into customer value and market opportunity.”

‘Future Designers’ is an interactive and participative crash course that aims to introduce to children the concepts and practice of creativity, design and design thinking. The title of the activity is purposefully ambiguous, as it can be interpreted both as “those who will become designers in the future” and “those who will design the future”. The main goals of Future Designers are to:

- Initiate children to a way of thinking and skill which can enhance learning, solve everyday problems and improve future employment prospects and quality of work.
• Empower, boost self-confidence, inspire and spark imagination.
• Help children discover and acknowledge their ability to imagine, create and have ideas of value of their own.
• Deliver a memorable and fun intellectual and emotional experience.
• Encourage collaboration among children, children and teachers, as well as children and parents.
• Sow the first seeds towards the creation of ‘micro-communities’ that are supportive and rewarding of creativity.
• Provide feedback to the scientific community about how children perceive contemporary technologies and design.

The course was created by Dimitris Grammenos, a highly experienced interaction designer and HCI researcher, as an attempt to adapt for young learners the syllabus of a post-graduate workshop on Design Thinking, building upon theoretical models of creative thinking and learning (e.g., Runco and Chand, 1995; Treffinger, 1980; Lewis, 2006). Initially, the course was intended for groups of 8-40 Primary School children (7-12 years old), with no related previous background or experience. Subsequently, through its experimental application in practice with various age groups (including middle, high school and university students, teachers and parents), it was found out that it can be successfully applied with practically any age group, even if it comprises participants of different ages (e.g., parents and children - working collaboratively or separately). The “backbone” of the course is a 500-slide PowerPoint presentation which includes high quality images, videos and music, but almost no text at all (except some minimal captions, e.g., names of personalities, section / activity titles).

2. BACKGROUND & RELATED WORK

2.1. Teaching Creativity

There is a substantial body of literature regarding how creative thinking can be modeled, the mental skills and processes involved, as well as the resources required for effectively supporting it. For instance, Runco and Chand (1995) have suggested a highly dynamic and recursive two-tier model of creative thinking, while Lubart and Sternberg (1995) have identified six resources as being critical to creative performance. The investment theory of creativity (Sternberg, 2012) also suggests the confluence of (about) the same resources as key creativity requirements.

Regarding learning and teaching about creativity, Treffinger (1980) has proposed a model for describing creative learning comprising three different levels with related cognitive and affective dimensions. Lewis (2006) presents a number of cognitive processes (‘modes of reasoning’) which are associated with creative production and suggests how they can be applied and trained in a classroom. Cropley (1995) summarizes a number of findings on the cognitive aspects of creativity that teachers should strive to promote in their students, Feldhusen and Treffinger (1980) provide a list of 10 recommendations for establishing a classroom environment conducive to creative thinking and another 7 suggestions for supporting an inquiry–discovery learning experience, and Sternberg and Williams (1996)
developed and presented 25 distinct strategies for teaching creative thinking organized. Finally, Osborn (1963) has introduced a 6-stage formal process for teaching and applying creative problem solving which has been widely used for the past 60 years.

2.2. Teaching Design Thinking & Design

Brown (2008) describes (a product- and market-oriented) design process as a system of three spaces, each of which delimits a set of related activities that altogether lead to innovation: *inspiration*, *ideation* and *implementation*. On the other hand, the Hasso Plattner Institute for Design (Goldman et al. 2009) considers six actions as key components of the design thinking process: Understand, Observe, Point of View, Ideate, Prototype, Test.

There are currently various efforts aiming at finding appropriate and efficient ways for introducing design thinking at schools. For example, ‘Taking Design Thinking to Schools’ (Goldman et al. 2009) was a qualitative research study aiming to explore how design thinking can be used as a tool for classroom learning and to extend related knowledge. The Smithsonian Cooper-Hewitt National Design Museum in New York has created a free program\(^1\) in the context of which a design educator visits classrooms and after providing a brief introduction to design through PowerPoint runs an activity called ‘Ready, Set, Design’. ‘Tools at Schools’\(^2\) is also a private nonprofit project where each year a school class partners with a corporation in order to design a new product. The American Institute of Graphic Arts has started an initiative for taking design thinking to elementary, middle and high schools\(^3\). Finally, the New Learning Institute, the Pearson Foundation, and COMMON studio have created the D3 process (Dream it, Design it, Do it) toolset\(^4\) which aims to build creative confidence and critical thinking in young people by teaching them how to think like designers.

3. The Crash Course

The Future Designers crash course is delivered by a main facilitator who is responsible for controlling the flow of the experience, lecturing and presenting, introducing and regulating the activities, prompting the children and keeping track of time\(^5\). The course builds upon the following key elements:

1. **Surprise**: For start, children get an invitation to the activity which states that the only item they should bring is their pillow. Going to school with your pillow is already an indication something ‘extra-ordinary’ will happen. Several additional surprises await children during the course.

2. **Variety**: Multiple learning styles and intelligences (Gardner, 1999) are supported through diverse teaching and learning approaches and multi-modal digital material. Even the place and position where children seat change quite often.

---

\(^1\) [www.cooperhewitt.org/education/school-programs/designk12](http://www.cooperhewitt.org/education/school-programs/designk12)

\(^2\) [www.tools-at-schools.com](http://www.tools-at-schools.com)

\(^3\) [www.aiga.org/Design-Ed-K12](http://www.aiga.org/Design-Ed-K12)

\(^4\) [d3lab.org](http://d3lab.org)

\(^5\) Additional helpers, including the children’s teachers, are employed mainly to support the various activities, e.g., distributing materials, triggering and coaching children, making sure that everyone is participating, etc.
3. **Cross-age appeal**: The content and activities are purposefully designed and selected to be engaging for all. In all pilots, participants of all ages, including teachers and parents, stated that they found them very stimulating and appealing.

4. **Active participation & hands-on activities**: Children are “co-drivers” of the activity and are given plenty of opportunities to actively engage individually and in groups, thus, following a ‘learning by doing’ constructivist approach (Papert, 1980) creating their own paths to knowledge. They are also free to cut-in and intervene at any time.

5. **(Team) Play & Competition**: Competitive activities are used to motivate children, but throughout them the importance of participation and effort are praised and winning is undervalued. Only moral - not tangible - rewards are offered (e.g., applause) to everyone. Winners get a supplementary round of applause.

6. **Humor & Fun**: As humor can promote divergent thinking (Flowers, 2001) and a supportive atmosphere provides freedom and security in exploratory thinking (Feldhusen and Treffinger, 1980), the course includes several opportunities that evoke children’s humor and laughter. Also, when discussing the results of the activities, humor is employed to dampen criticism.

7. **Music**: Music is used in two different ways. During the hands-on activities, soft, dreamy orchestral music is played to support children’s creative process and give them inspiration and new, imaginative ideas (Tikkanen, and Iivari, 2011). Additionally, a musical ‘sting’ is employed at regular intervals to punctuate interesting events and important moments (e.g., successful completion of an activity, answer to a question) and also as a cue for group ‘decompression’; as long as it lasts everyone is free to stand, jump, dance, laugh, sing or shout.

8. **Imagination**: The course provides material, triggers and activities that appeal to the children’s imagination rather than to their logic, to “support and reinforce unusual ideas and responses” (Feldhusen and Treffinger, 1980).

The course is structured as depicted in Fig. 1. A more detailed description is provided in (Grammenos, 2015). In essence, the Future Designers crash course tries to implement the advice provided by Torrance (Torrance, 1972), also exploring new ways for creatively “teaching” non-traditional subjects like creativity and design. In contrast to most related efforts, children are explicitly taught about their ability to think creatively, so as to gain more control over it, foster creativity consciousness, demystify creativity, and increase creative ideas and products (Davis, 1982). The course comprises 2 individual and 2 team activities.
3.1. Activity 1 (indiv.): Designer for a while

**Aim**: Perform an act of (iterative) design through an easy first step, which is close to the children’s “zone of proximal development” (Vygotsky, 1962); introduce the concepts of design requirements and design decisions; prove to children they all have the ability to innovate.

**Approach**: Children are invited to design a very simple object - a spoon - using colored pens or plasticine (Fig. 2). No explicit time limit is set; the facilitator emphasizes that there will be no judgment. When everyone has finished, the facilitator (using his absentmindedness as a playful excuse) introduces, step by step, a number of design requirements (e.g., it was...
meant to be a teaspoon, cheap but environmentally friendly, for Tinker Bell the tiny fairy). At each step, children are asked to change their design or make a new one. In the end, the facilitator notes the pieces of information used (who, what, why, where, preferences, cost), each yielding a different design decision. He also points out that each child has designed a unique object—although millions of spoons already exist—thus rightfully meriting the title of “designer”.

3.2. Activity 2 (indiv.): What makes me dream?

Figure 3: What makes me dream?

Aim: Reinforce the fact that children have the power to dream/imagine; reflect about what may trigger this process and discover additional triggers from peers.

Approach: Children use colored pens and Post-it notes to write and/or paint what makes them dream and imagine. Then, they stick their note on a cardboard cloud while also reading/describing its content (Fig. 3).

3.3. Activity 3 (team): The marshmallow challenge

Figure 4: The marshmallow challenge.

Aim: Collaborate, communicate, and employ creative thinking to solve a predefined problem; practice learning through experimentation, failure, and iterative design.
Approach: The Marshmallow Challenge as originally introduced by Tom Wujec is used. Children are randomly assigned to teams of three. In 18 minutes, each team must build the tallest freestanding structure out of 20 sticks of spaghetti, two meters of paper tape, 10 pieces of string, and one marshmallow (Fig. 4). At the end of the challenge, the facilitator communicates that winning is not as important as thinking creatively and having fun. Each time a team’s structure is measured, everyone applauds—even in the case of failure, as failures should also be celebrated in design.

Activity 4 (team): Inventing for my school

Figure 5: Inventing for my school.

Aim: Collaborate, communicate, and employ creative thinking to select a problem to be solved; devise an innovative solution; present it to peers; constructively assess the work of others. This activity covers all of the parts of Runco and Chand’s (1995) model.

Approach: The core of this activity is based on the ‘Ready, Set, Design’ activity of the Smithsonian Cooper-Hewitt, National Design Museum, but with two key additions. The first one is that children are asked to define the problem they want to solve. The reason for this is three-fold: (i) problem finding is considered an important aspect of creative thinking and behavior (Csikszentmihalyi, 1996); (ii) it can greatly help increase the intrinsic motivation of learners (Runco, Nemiro, 1993); and (iii) one needs to know enough about a field to be able to innovate (Csikszentmihalyi, 1996; Sternberg, 2012) and avoid “reinventing the wheel”. The second addition is the evaluation of the inventions by the children—not the facilitator—according to several criteria, to allow them reflect on the outcomes of design and think about design strengths and weaknesses (Kimbell, et al. 1996). New random teams of four members are formed (Fig. 5). Their first task is to ideate a new invention for their school, according to the following requirements: (i) the invention can be used for any purpose; (ii) it has to be used in their school (it can also be portable); (iii) it may use any kind of existing, future, or imaginative technology; (iv) nothing similar should already exist. Since there is evidence that explicit instruction can affect the novelty and value of created ideas, children are asked to “be creative” and to “give ideas that no one else will think of” (Harrington, 1975). In the first 15 minutes, each team has to fill in an “Invention Declaration Form”

6 http://marshmallowchallenge.com
7 www.cooperhewitt.org/education/school-programs/designk12
comprising 5 fields: (a) invention name, (b) role / target use, (c) users, (d) place of use, and (e) first names and ages of the team members.

Each team receives simple materials, such as paper plates and cups, balloons, aluminum foil, and rubber bands, but not glue, tape, or scissors. Building upon Karl Duncker’s “candle box experiment” for detecting “functional fixedness” (Duncker, 1945), the prototyping materials are provided inside a paper tray but no explicit clarification is given whether this can also be used for constructing the prototype. Teams have 25 minutes to build an experimental prototype. When time is up, each team briefly presents its invention. All other teams evaluate it according to five criteria: name, originality, usefulness, ease of use, and desirability. Evaluation is rated using cardboard sheets depicting 1 to 3 light bulbs to stress that even if an idea scores low, it still remains an idea. Evaluators are challenged to justify their score and provide constructive feedback, while the team being evaluated can rebut.

4. PILOT STUDIES

Future Designers follows a learner-centred design approach, in the context of which the course is being iteratively evaluated and tested in real settings with representative stakeholders through pilot studies with complementary characteristics and goals. Up to now, the course has been tested in 5 different pilots, four of which in real school settings. The overall goals of the pilots were:

1. To assess the feasibility of the course and its ability in attracting and maintaining interest by children.
2. To assess the ability of Future Designers to involve children in design activities such as problem identification, generation of ideas, prototyping and critique.
3. To assess the level of satisfaction and fun during the Future Designers experience.
4. To preliminary assess the potential of Future Designers as a participatory design method with children.
5. To identify the strengths and weaknesses of the approach and of the presented content and devise related improvements.

All the above were assessed throughout all the pilots. All pilots were followed by at least two assistant observers, who recorded interesting related data, as well feedback and comments by children, teachers and parents. A large quantity of material has been collected including notes, pictures, videos, etc. Spontaneous feedback by the attendees was also received in many cases. Subjective user opinion data were collected through structured questionnaires in pilots 3 and 4.

4.1. Pilot 0: Teachers & Post-Graduate Students (+ Children)

Goal: Preliminary assess the suggested concept and approach, as well as its potential applicability and practical value.

Implementation: When a first draft version of the course’s material was compiled, it was presented during a 3-hour session to a group comprising 8 primary school teachers and 4 post graduate students in the field of HCI, specializing in design. The session was held in a room simulating a classroom environment. Initially, the key philosophy and ideas upon
which the course was created were presented. Then, participants assumed the role of children, actively participating, but with the option to openly discuss and comment at any time. Due to time constraints the last team activity was only described and not experienced. A few hours before the pilot, most of the content was presented to two children (7 and 9 years), who also playtested the three first creative activities.

Outcomes: The participating teachers were very excited and found the course very interesting, fun and stimulating. They suggested running a full-scale pilot of the course as an activity of their school’s reading club. The participating children were highly engaged and affirmed that they had a great time.

4.2. Pilot 1: Primary School Children

Goal: “Test-drive” the course in a real setting with real learners. Identify what works and what not.

Implementation: The pilot took place in cooperation with the reading club of the 12th Public Primary School of Heraklion, Greece. The participants were 12 children of the 5th (~10 years old) and 10 children the 6th grade (~11 years old). The pilot was implemented in two afternoon sessions, the first of which lasted 3 hours (covering everything up to the last activity) and the second lasted 2 hours. Both sessions were held in a classroom of the children’s school. Since the second session was held after one month, it started with a short recap of the previous one.

Outcomes: In both sessions children were enthusiastic, they had a lot of fun, but also showcased great levels of creativity producing very innovative and interesting ideas and concepts. The feedback that teachers got from the children’s parents was also very positive, as many of them stated that their children returned home very excited and eager to narrate them as much as they could remember from their experience.

4.3. Pilot 2: Teachers

Goal: Get feedback from a large number of educators about the course, including ideas, concerns and potential of adopting it.

Implementation: Following the success of Pilot 1, a 5-hour seminar was implemented involving 25 primary school teachers in a classroom environment. After an introduction of about 30 minutes regarding the goals, philosophy and approach of Future Designers, the participants assumed the role of children and experienced the whole activity. Like in Pilot 0, the teachers were able to openly comment and discuss during the whole process.

Outcomes: The feedback from this pilot was very positive, reinforcing previous findings. All of the participating teachers said that they would like to run Future Designers with their classrooms. Very few participants who appeared to be less interested in the beginning, became more involved as the course progressed. A couple of teachers expressed concerns about ‘yet another subject in school’, but when the purposes and philosophy of the course were explained, they all expressed positive opinions. Overall, teachers were very collaborative and stated that they enjoyed the Future Designers experience.
4.4. Pilot 3: Primary School Children + Parents

**Goal:** Confirm the positive feedback from previous pilots; collect structured evaluation data; gather also parents’ opinions about Future Designers; obtain preliminary feedback about the potential of Future Designers to engage children and adults together in creative activities.

**Implementation:** This pilot was held at the 2nd Public Primary School, Voutes, Heraklion, Crete, Greece with the participation of 20 children of the 5th (~10 years old) and 6th grade (~11 years old) and 18 parents of ages from 36 to 71. The course was held on a Saturday morning and lasted four hours. Group activities were conducted with homogenous groups of children or adults. Following the course, two slightly different evaluation questionnaires were distributed to children and parents. The questionnaires were brief, including 2 demographic questions, a small number of rated response questions (11 for children, 12 for parents), 1 overall mark question and some open-ended questions (3 for children, 5 for parents). Rated questions concerned the novelty of the experience, level of interest, fun, and learning, satisfaction from participation, tiredness, length of the course, number of intervals, experience of participating together with children/parents, etc. Open ended questions concerned aspects that were liked / disliked, and general feedback.

**Outcomes:** Answers to the questionnaires were obtained (anonymously) from 17 children and 15 parents. The very positive results are reported in Section 5, with an overwhelming majority of enthusiastic responses and no negative response.

4.5. Pilot 4: Middle School Children

**Goal:** Assess the applicability and success of the course to Middle school children.

**Implementation:** Although initially the course was mainly targeted to primary school children, its cross-age appeal and design suggested that it could also be applicable to older children. To test this hypothesis, a pilot was conducted at the 1st Public Middle School, Heraklion, Crete, Greece, involving 27 children from 12 to 15 years old. The course was held in the morning of a bank holiday day and lasted four hours. To better suit the intended audience, some of the PowerPoint slides that were originally depicting cartoon characters were replaced by photos and realistic imagery with an equivalent meaning. The questionnaire used in Pilot 3 (in the version for children) was used also in Pilot 4 (except some questioning referring to parent participation).

**Outcomes:** The pilot went overall very well, but it was apparent that older children were less enthusiastic and less creative than younger participants in the previous pilots. Teams were also less collaborative and not all children participated actively in the prototyping of the inventions. Answers were gathered from 22 children. The results are presented in Section 5.

5. RESULTS

All hands-on activities proved to be well received by participants of all ages and achieved their foreseen function and aims. This section reports on observational data and the outcomes of these activities in Pilot Studies 1 - 4.

**Activity 1: Designer for a While (The spoon)**
The first aim of this activity was to be an act of deliberate design that everyone is able to perform. This objective was achieved 100%, as all 112 participants of the Pilots successfully completed all the (re)design steps. Everybody participated and enjoyed the “reversals” which were welcomed with a very positive attitude and laughs. No one ever complained about the consecutive redesign requests. The second objective was to empower participants by proving to them that they all have the ability to innovate. This was also achieved, since most of the crafted spoons (even the ones made with plasticine) were surprisingly original. Most adults (Pilots 2 & 3) needed considerably more time to (re)design their spoons. Also, this was the only activity where older children and (some) adults (especially teachers) came up with more creative results than primary school children.

**Activity 2: What Makes Me Dream?**

This activity yielded a range of responses from primary school children (Pilots 1 & 3), all the way from simple and commonplace (e.g., “love and friendship”, “the sea and the sky”), to highly imaginative or even poetic (e.g., “When you are dreaming you don’t think if there is right or wrong. Every good thing has dreams, even the bad ones”, “Hope for something new that we or someone else will have created”). Most of the teachers (Pilot 2) gave very simple and conventional answers comprising a short list of nouns (e.g., the sea, music, rainbows, love). Few used some verbs (when I see the rainbow, when I paint). Some drew just a minimal sketch (e.g., the sea, the sun and some flowers), or decorated their list of words with little symbols (e.g., a musical note, a heart). Most adults in Pilot 3 wrote down just a single word. For obvious reasons, “(my) children”, was one of the most popular answers among them. In Pilot 4, children were considerably more succinct and conventional than primary school children. Only 4 of them included a minimal drawing illustrating their keyword (e.g., a smiley, some hearts, a cloud) and another 4 included a hashtag (#) in front of their keywords, a practice commonly employed in computer social networks. In all pilots there were at least 1-2 answers related to “sleeping”! Overall, younger children were more expressive and imaginative in their answers than all other groups. Fig. 6 showcases a representative post-it note from each group.

![Image showing post-it notes from Activity 2](image_url)

**Figure 6.** What makes me dream? Representative answers: primary school children, teachers, parents, middle school.

**Activity 3: The Marshmallow Challenge**

In accordance to evidence from the application of this activity with various audiences worldwide, the marshmallow challenge proved to be an enjoyable experience for participants of all ages (manifested through their laughter and joy through it, as well as from the fact that in all pilots there was no person who did not actively participate), and fostered intense collaboration among group members. Interestingly, depending on the age of the participants, there were considerable differences in the process followed, the model built and the success of the outcomes.
In Pilot 1, all 6 teams succeeded in creating standing structures. The tallest was 64.5 cm. There was considerable diversity in the type of structures created, and more than half of the teams built incremental prototypes, i.e., they first created a shorter standing structure, and then tried to gradually make it taller (especially when they noticed another team surpassing them). In Pilot 2, only one team did not succeed. The tallest structure was 59 cm. In contrast to children in Pilot 1, all teams built the same type of pyramid-like structure and (except one) they built it in a single step without experimenting or trying to improve it. In Pilot 3, the highest structure built by children was 48 cm, while parents reached 68 cm. Only one team of each group was not successful. Most teams of both groups relied on the pyramid-like structure. Parents got very engaged and excited during this activity and one of their teams created the most elaborate structure built in anyone of the Pilots. On the other hand, one of the children’s team built the simplest structure comprising a single ‘pole’ of spaghetti supported by a lot of external strings. In Pilot 4, four out of nine teams did not create a standing structure, but the tallest one was 77 cm. Four teams deviated from the pyramid-like structure. All teams followed an “all or nothing” approach, building a single model and sticking to it. Even when a team with a standing structure noticed another one surpassing them, they refused to try to improve it due to the fear of failure. In other words, they were more satisfied with a mediocre success than following a more ambitious yet riskier approach.

Activity 4: Inventing for my School

Overall, in this activity there was diversity and little overlap among the inventions conceptualized in all Pilots. Most prototypes were creative and had aspects of novelty. Parents’ prototypes were more conventional both from a conceptual and a construction point of view, followed by middle school children. Some of the teacher groups came up with very original ideas, while a number of primary school children’s creations were totally unpredictable. Table 1 summarizes the key characteristics of each invention (please note that ‘Originality’ was subjectively rated using 1-5 stars for the needs of this publication by 5 design experts – 5 stars = highly original idea, 1 star = copy of an existing idea - and that the invention names have been heuristically transliterated from Greek). The help cards prepared to suggest inventions to teams short of ideas were never used, revealing that this was a really redundant concern. Except teachers, most other user groups used the paper tray containing the materials as part of their prototypes. Balloons also proved to be very popular. In terms of collaborative spirit and skills, primary school children excelled, closely followed by teachers. Parents also did quite well, while more than half of the middle school teams faced considerable cooperation problems. During evaluation, younger children, teachers and adults were generous with their scoring, trying to be nice to their peers. Younger children enjoyed the evaluation the most and were very careful in deciding scores and providing comments. Some teams had initial difficulties in reaching an agreement about the scores, but all did it in the end. Middle school children mainly scored based on personal friendships or aiming to revenge less favorable scoring by other teams. Furthermore, since evaluation in middle school is tightly linked to academic success and failure, many children stated that they did not like the fact that others evaluated their projects.
<table>
<thead>
<tr>
<th>Pilot</th>
<th>Group</th>
<th>Invention</th>
<th>Goal</th>
<th>End users</th>
<th>Place</th>
<th>Originality</th>
<th>Score</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Children</td>
<td>Magicoseabox</td>
<td>Recreation</td>
<td>Students</td>
<td>Portable</td>
<td>★★★★★</td>
<td>68/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Electronic table</td>
<td>Eating</td>
<td>Students</td>
<td>School yard</td>
<td>★★★★★</td>
<td>68/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flying desk</td>
<td>Student reward</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>65/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Ermolaos (robotic pigeon)</td>
<td>Assistant</td>
<td>Everyone</td>
<td>Mobile</td>
<td>★★★★★</td>
<td>65/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Robotoschoolguy</td>
<td>Assistant</td>
<td>Students</td>
<td>Mobile</td>
<td>★★★★★</td>
<td>63/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mathotipia</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>59/75</td>
</tr>
<tr>
<td></td>
<td>Teachers</td>
<td>Grrr…Ha!Ha!Ha!</td>
<td>Emotional support</td>
<td>Everyone</td>
<td>Entrance</td>
<td>★★★★★</td>
<td>72/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>I see inside</td>
<td>Emotional support</td>
<td>Everyone</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>69/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Chaos into order</td>
<td>Tiding up</td>
<td>School</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>67/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Beach work</td>
<td>Student reward</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>65/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Smart chair</td>
<td>Comfort</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>58/75</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Hologrammatic adjustment through a smart chair</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★</td>
<td>31/75</td>
</tr>
<tr>
<td>2</td>
<td>Parents</td>
<td>Interactive desk</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★</td>
<td>93/100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Fun floor</td>
<td>Teach dance, sports &amp; games</td>
<td>Students</td>
<td>Classroom</td>
<td>★★</td>
<td>92/100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Experience</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>91/100</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>Wish box</td>
<td>Wish fulfilling</td>
<td>Everyone</td>
<td>Portable</td>
<td>★★★★★</td>
<td>91/100</td>
</tr>
<tr>
<td></td>
<td>Parents</td>
<td>Vegmenax</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>88/100</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>Diving simulator room</td>
<td>Diving simulation</td>
<td>Students</td>
<td>New room</td>
<td>★★★★★</td>
<td>85/100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Teacher’s eyes</td>
<td>Cheating detection</td>
<td>Teachers</td>
<td>Classroom</td>
<td>★★★★★</td>
<td>84/100</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic backpack</td>
<td>Lesson assistance</td>
<td>Students</td>
<td>Wearable</td>
<td>★★★★★</td>
<td>83/100</td>
</tr>
<tr>
<td></td>
<td>Children</td>
<td>Flying Book Carrier</td>
<td>Assistant</td>
<td>Students</td>
<td>Mobile</td>
<td>★★★★★</td>
<td>74/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Instatus Sybadius</td>
<td>Space travel</td>
<td>Students</td>
<td>Vehicle</td>
<td>★★★★★</td>
<td>72/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Flying Time Machine</td>
<td>Learning support</td>
<td>Students</td>
<td>Classroom</td>
<td>★★</td>
<td>70/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>InfoGlasses</td>
<td>Google-glass like</td>
<td>Students</td>
<td>Portable</td>
<td>★★</td>
<td>69/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>What Did You Say?</td>
<td>Acoustic isolation &amp; music</td>
<td>Students</td>
<td>Classroom</td>
<td>★★</td>
<td>50/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>See-through Binoculars</td>
<td>Identify absent students</td>
<td>Teachers</td>
<td>Wearable</td>
<td>★★</td>
<td>45/85</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Automatic Corrector</td>
<td>Spell checking &amp; correction</td>
<td>Teachers</td>
<td>Classroom</td>
<td>★☆</td>
<td>41/85</td>
</tr>
</tbody>
</table>

Table 1. Key characteristics of the inventions created in each Pilot Study

(Originality scores were subjectively and independently rated by 5 design experts)

In Pilot 1 (Fig. 7), one of the teams admitted of first finding a name for their invention, and then its function. When they were given the prototyping materials, almost everyone started immediately to work with it. The teams showed a high degree of cooperation. There was not a single child who did not actively contribute. In two of the teams there was a child that clearly had a leading/organizing role. All teams blew the balloons and 5 out of 6 actually used them. Five teams also used the paper tray as part of their prototype. Most teams tried to use all the available materials, even if they did not fit to their concept. One of the two highest rated inventions was the Magicoseabox, a small box that you can have in your pocket. When you open it an orange sea comes out, in which children can swim without getting wet, they can play and read, and do whatever they want without any parents around. Also, in there everything is free (e.g., restaurants, shops).
In Pilot 2 (Fig. 8), once again, one team first found the name and then the use of its invention, but this was because the team included a primary school child who was accompanying his mother. Three out of six inventions were related to identifying, expressing, and turning to positive student emotions. The invention that got the highest total score was “Grrr...Ha!Ha!Ha!” a chamber, strategically placed at the school’s entrance so that everybody passes through it, that converts negative thoughts and feelings into positive ones (Fig. 8, left). Other two inventions were related to student comfortable seating. Only one team used the paper tray as part of the prototype. In general, compared to children’s creations, teachers’ inventions had very targeted and practical goals.
In Pilot 3 (Fig. 9), the most highly rated invention was designed by a group of parents. It was the Interactive Desk that children can use to display books, exercises, labs, maps, etc., and to communicate with other children. Parents’ inventions were quite ordinary and meant to support the educational process, reflecting the fact that parents think of schools as a place where children go to learn. One of the teams also put particular emphasis to the fact that their invention should always be used under adult supervision. The parents’ teams were also very excited during the presentation phase and gave very vivid and cheerful demonstrations. Children came up with some very imaginative inventions, like the Wish Box, a box which makes wishes come true; a Diving Simulator Room including special glasses which make their wearer see and feel as being underwater; and the Teacher’s Eyes, a flying device aiding teachers to spot children that are cheating during tests. Interestingly, during the desirability question of the evaluation session, the inventors of the Teacher’s Eyes prompted everyone to vote against it! All children teams used the paper tray, as well as 3 out of 4 parents’ teams.

In Pilot 4, the most highly voted invention was the Flying Book Carrier, a device to carry books and capable of recognizing children and following them. Overall, most inventions were not very innovative and, more or less, constituted adaptations of commonplace ideas. Five out of seven teams used the paper tray. Also, in 4 teams there was at least one member that did not agree with the others’ decisions and constantly disputed, or even refused to collaborate. In comparison to the other Pilots, many children were less focused on the task and from time to time would drift to other activities, or get up and check what other teams were up to.

6. Conclusion & Future Work
This paper has reported the experience acquired through a number of pilots of Future Designers, involving children of various ages (from 10 to 15 years), teachers and parents. The crash course has proved in practice to be a very engaging and fun experience, both for children and adults. Furthermore, it has achieved to raise interest in personal and social creativity and innovation. Despite its length and high mental and physical demands, when it ends participants (including the organizers) feel happy, motivated and full of positive energy. Stated levels of satisfaction and fun are very high for participants of all ages.
A valuable lesson that we have learned through the (successful) application of the course to a large variety of age (even cross-age) groups, also beyond the pilots reported in this article, is that, for topics that do not build upon prerequisite knowledge and skills (e.g., like Mathematics or Physics), it is possible to create introductory courses that can be applied to practically any age-group, by just varying appropriately the wording employed during its delivery, but not its fundamental approach, content or materials.

The full course typically lasts 4-5 hours (usually with just a 10 minute break after the first couple of hours). Sometimes, due to time limitations, it has been delivered in two separate sessions of 3 and 2 hours, and no negative effects have been observed. Also, shorter versions have been delivered, ranging from 40 minutes to 2 hours. In these cases, the course is mainly based around the hands-on activities and related discussions, accompanied with a small amount of context information. In the 40 minutes version, Activities 1 and 3 were employed, in a 1-hour version Activities 1 and 4, and in longer versions all four of them. In any case, our practical experience from experimenting with various course setups (which is currently beyond the scope of this article) has shown that Activities 1-3, as well as the steps among them, play a crucial role in setting a mindset and emotional state of participants for Activity 4 that yields innovative and creative results.

Overall, the acquired experience, although it does not provide a full validation of the Future Designers course from an education and creativity point of view, demonstrates that the course achieves its goal of widening the participant’s horizon and inspiring a positive attitude towards design and creativity, by showing in practice that everybody can have good ideas, and that ideas can be showcased through simple prototypes built out of common everyday objects.

Acknowledgements
We would like to thank our colleagues from the HCI Lab for their invaluable help in running the pilots, as well as all the participating children, teachers, and parents.

References
Sternberg, R. J., & Williams, W. M. 1996. How to develop student creativity. Association of Supervision and Curriculum Development, Alexandria, VA.
Torrance, E. P. 1972. Can We Teach Children To Think Creatively?. The Journal of Creative Behavior, 6: 114–143.