

The Role of New Technologies to Foster Positive Youth Development

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This article describes a developmental systems approach to applied developmental science (ADS), which provides a framework to design and evaluate technology-rich programs that promote positive development by emphasizing the strengths and assets of young people instead of focusing on diminishing or preventing risk-taking behaviors. Until now, most of the psychoeducational programs conceived within the ADS model have not focused on the role of new technologies in young people's lives. This absence is particularly striking given that, in today's world, new technologies play an important role in different areas of the lives of young people, such as education, entertainment, socialization, and communication. This article presents the concept of identity construction environments (ICE), an interdisciplinary model that proposes guidelines to design and study new technologies purposefully created to promote positive youth development (PYD). Two types of ICE have been developed: one focusing on stand-alone technologies for learning, such as the Zora virtual city; and the other focusing on an approach for developing technologically rich learning contexts, such as the Project Inter-Actions robotics workshops. This article presents both examples of ICE and describes how their design fosters the 6 components of PYD. Initial findings from pilot studies conducted with very different populations of youth engaged in both types of ICE—such as young children, adolescents, and chronically ill children—are presented.

A developmental systems approach to the application of developmental science provides a framework to design and evaluate programs and policies that may promote positive development in young people by focusing on their strengths and the ecological assets that may nurture these strengths. This approach may be contrasted with deficit approaches that focus on diminishing or preventing risk-taking behaviors. Most of the programs conceived within the developmental systems approach have not attended to the role of new technologies in young people's lives or have limited their use to information delivery or retrieval. This omission is particularly striking given that in today's world new technologies play an important role in different domains of the lives of youth, such as education, entertainment, socialization, and communication.

This article presents a theoretical model, supported by the beginning of an empirical research program, to design and study new technologies aimed at promoting positive youth development (PYD). The purpose of this article is to introduce to the applied

developmental science (ADS) community an innovative research approach to understand PYD in the context of new digital technologies used in complex real-world settings.

The importance of this endeavor is underscored by the fact that children and teenagers are increasingly using computer-based applications for educational, entertainment, and social activities. For example, from 1993 to 1999, the number of Americans connected to the Internet grew from 3 million to 80 million. Families with children represent one of the fastest-growing segments of the population using the Internet. By the end of 2002, 58% of U.S. residents were expected to access online services from home (Montgomery, 2000). And by 2004, 44% of American Internet users have contributed their thoughts and digital content to the online world (Pew Internet & American Life Project, 2004). In 2005, youth 8 to 18 years old spend an average of 1 hr per day using the computer. More than 8 in 10 (86%) have a computer at home, and three in four (74%) have a home Internet connection (31% have high-speed access). Nearly one third (31%) have a computer in their bedroom, and one in five (20%) have an Internet connection there (Kaiser Family Foundation, 2005).

Given this data, the terrain is fertile to develop computer-based applications and technologically rich interventions that specifically provide opportunities

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for promoting PYD. Their development, however, requires interdisciplinary work by theorists and practitioners in child development and computer sciences. Not all of the new technologies lend themselves to fostering PYD. Neither can all of these technologies be integrated into successful face-to-face programs.

In previous work, I have coined the term *identity construction environments* (ICE) to refer to technologies and technologically rich psychoeducational interventions (Bers, 2001). In this article, I present a theoretical framework for understanding ICE in the context of PYD. The interdisciplinarity of the framework provides an opportunity for practitioners and researchers to engage in collaborative efforts in the design and study of new technologies to promote PYD. This theoretical framework also provides a model that might guide policy and decision making toward implementing or evaluating new technologies to foster PYD.

The core contribution of this article is the interdisciplinary theoretical framework explained in the next paragraphs. In the following sections of the article, data from pilot empirical studies are used to support the usefulness of the framework. ADS provides the context for the development of the notion of PYD. This involves cognitive, personal, social, emotional, and civic aspects of young people, which researchers refer to as the six "C"s: *Competence* (cognitive abilities and healthy behavioral skills), *Connection* (positive bonds with people and institutions), *Character* (integrity and moral centeredness), *Confidence* (positive self-regard, a sense of self-efficacy), *Caring* (human values, empathy, and a sense of social justice) and *Contribution* (orientation to contribute to civil society; Lerner, 2002; Lerner, Fisher, & Weinberg, 2000; Lerner et al., 2005). Together, these characteristics reflect a growing consensus about what is involved in healthy and positive development among people in the first 2 decades of their lives (Scales, Benson, Leffert, & Blyth, 2000).

The PYD framework within ADS informs the design of a particular kind of new technologies labeled by Bers (2001) as ICE. The term *identity* is used here to signify the distinguishing character or personality of an individual. Thus, ICE are computational environments in which young people can experiment with distinguishing aspects of who they are. ICE provide design elements that engage youth in exploration and promotion of the six Cs. The use of ICE in youth programs can complement and/or augment the potential benefits of face-to-face psychoeducational interventions (Bers, 2001, 2003; Bers, Gonzalez-Heydrich, & DeMaso, 2001). ICE are specifically designed to promote PYD by adhering to 10 design guidelines. According to these guidelines, a technology or technologically rich intervention that hopes to promote PYD (i.e., ICE) should

1. Provide a safe space¹ in which youth can design and program personally meaningful computer-based projects that highlight and make accessible concepts and ways of thinking about identity and values.
2. Support young users to use technology to engage in self-reflection and introspection.
3. Provide opportunities to engage in interactive design-based activities to learn about self and community by becoming technologically fluent. The nature of design-based activities engages young people in developing attitudes, knowledge, and skills about new technologies. In turn, developing technological fluency enables youth to see themselves as competent learners of skills and knowledge that are highly valued by modern society.
4. Provide dynamic computational tools with which users can create a complex representation of the self, highlighting its multiplicity of aspects and its changes over time.
5. Provide diverse and flexible computational media to express and explore powerful ideas about identity in different ways (e.g., writing a story, drawing a picture, programming an interactive character, chatting with others, etc.).
6. Provide opportunities for children to engage in narrative expression, particularly in telling stories about the self, using the power of new computational and communicational tools.
7. Provide technologies that engage and motivate users to work on their own technologically rich projects for long periods of time in a natural and self-initiated way.
8. Make use of networked technologies to create a virtual community to put to test new concepts and ways of thinking and behaving.
9. Support the passage from knowledge to action by engaging users in collaboration. Namely, provide opportunities for community-supported collaborative learning (CL), in which learners can use technologies to express their sense of self, as well as explore their identity through behaviors in the context of a community of practice.
10. The technologies should be designed following a participatory method in which potential users, both professionals and children, become

¹A safe space means that participants are protected by agreeing to sign a code of conduct that sets a baseline of camaraderie and respect, and by having a password protected world—in the case of Zora—so that only participants can be part of the virtual community. This is particularly important given that by engaging with ICE, youth are invited to reflect about very personal issues such as values, beliefs, and concepts of self.

partners in the different stages of the design and development process.

The previously mentioned 10 design characteristics of ICE are observed on software specifically designed with the goal of fostering PYD, such as the Zora virtual world described later in this article, or in technologically rich environments that use already existing technologies that were initially developed with other goals but that are integrated with a positive development framework. An example of this is Project Inter-Actions, a robotics workshop that is described later in this article. These guiding design principles might also inform decision making regarding the use or adaptation of already existing popular computer applications, such as video games. For example, these guidelines can be used as a checklist against which to evaluate the potential of some video games or Internet Web sites for PYD.

The following section of the article presents examples of how ICE design principles have an affect on the types of learning experiences of youth who engage with them. Regardless of the particularities of the two distinct types of ICE, which is visited later, their design affordances that support the development of the six Cs are consistent with the recent survey of research included in the *Community Programs to Promote Youth Development* (Eccles & Gootman, 2002). This highlights possible benefits of integrating ICE into already existing or newly developed face-to-face psychoeducational programs and interventions to reach a wider audience and a geographically distributed population.

The design and evaluation of ICE is informed by three main bodies of work: the constructionist theory of learning, which has specifically focused on the role of technology in education (Papert, 1980); current research on virtual communities; and work on narrative theory and its impact on identity formation. The contributions of these three areas of study, as they inform ICE, are described in the following sections.

Constructionism: A Constructivist Philosophy for Educational Technologies

During the last 30 years, the role that computers and other computer-based technologies play in education has grown dramatically. Kochmann (1996), borrowing from Kuhn's notion of scientific paradigms, identified four major paradigms in the evolution of educational technologies: computer-assisted instruction, intelligent tutoring systems, constructionism, and computer-supported CL. Each of these paradigms contains different pedagogical and methodological approaches

to conceive and to integrate computer-based technology in the teaching and learning process.

The constructionist theory of learning plays an important role in the design and evaluation of ICE. Constructionism, developed by Seymour Papert, asserts that computers are powerful educational technologies when used as tools for supporting the design, construction, and programming of personally and epistemologically meaningful projects (Papert, 1980; Resnick et al., 1996). By constructing an external object to reflect on, people also construct internal knowledge. Constructionism has its roots in Piaget's constructivism (von Glasersfeld, 1978; Piaget, 1965). Whereas Piaget's theory was developed to explain how knowledge is constructed in our heads, however, Papert paid particular attention to the role of constructions in the world as a support for those in the head. Although constructionism has both theoretical and practical limitations—namely, the lack of theoretical conceptualization of the role of sociocultural theory in designing learning environments (Brown et al., 1989; Rogoff, 1994) and the difficulties of applying constructionism in formal institutions such as schools (Papert & Harel, 1991)—for the purpose of ICE, it offers the framework for developing a design-based learning environment, in which learning happens best when learners are engaged in learning by making, creating, programming, discovering, and designing their own "objects to think with." Voluminous literature exists about theories of learning that support the premise that learning by designing is a successful method and provides different vocabulary: project-based learning, problem-based learning, constructivism, constructionism, learning by design (Kolodner et al., 1998). In the case of ICE, youth are learning about their own selves and communities by developing the six Cs while engaging in the design of a computational artifact such as a virtual city or a pet robot.

Constructionism is situated in the intellectual trajectory started in the 1960s by the Massachusetts Institute of Technology (MIT) Logo Group, under the direction of Seymour Papert, based first at the Artificial Intelligence laboratory at MIT and later at the MIT Media Laboratory. Although the Logo Group members held many different research agendas and goals, the collective vision of the group rested primarily on at least four major pillars identified by Bers (Bers, Ponte, Juelich, Viera, & Schenker, 2002).

First, the group believed in the constructionist approach to education. Strongly based on Piaget's constructivism, Papert's theory of constructionism emphasizes the need for technological environments to help children learn by doing, by actively inquiring, and by playing. The interaction with the technological materials around them provides children the opportunity to design and make meaningful projects to share with a

community. *Second, the group understood the importance of objects for supporting the development of concrete ways of thinking and learning about abstract phenomena.* In this context, computers acquired a salient role as powerful tools to design, create, and manipulate objects in both the real and the virtual world. The group envisioned this technology existing not only in the form of current desktop computers, but also as tiny computers embedded in Lego-bricks that could be programmed to move and respond to stimulus gathered by touch or light sensors (Bers et al., 2002; Martin, Mikhak, Resnick, Silverman, & Berg, 2000). This technology is described later in the section focusing on Project Inter-Actions. *Third, the group valued the notion that powerful ideas empower the individual.* Powerful ideas afforded individuals new ways of thinking, new ways of putting knowledge to use, and new ways of making personal and epistemological connections with other domains of knowledge (Papert, 2000). Constructionists envisioned the computer as a powerful carrier of new ideas and particularly as an agent of educational change. *Fourth, the group embraced the importance of self-reflection.* The best learning experiences occur when individuals are encouraged to explore their own thinking process and their intellectual and emotional relationship to knowledge, as well as the personal history that affects the learning experience. Constructionism viewed the programming of a computer as a powerful way to gain new insights into how the mind works and learns (Papert, 1993).

Papert's constructionism became widespread in education in 1980 with the publication of his pioneering book, *Mindstorms: Children, Computers and Powerful Ideas* (Papert, 1980). Although there is a long-standing constructionist tradition in developing authoring tools and programming environments for children's learning about mathematics and science (Harel & Papert, 1990; Kafai, 1994; Resnick, Berg, & Eisenberg, 2000; Resnick, Bruckman, & Martin, 1996) and for creating virtual communities to foster peer learning and collaboration (Bruckman, 1998; Evard, 1996; Pinkett, 2000; Resnick et al., 1996), little work has been done within this tradition to design computational environments to promote PYD (Bers, 2003). Constructionism informs the design of ICE by highlighting the importance of providing authoring tools for people to create their own meaningful projects and communities.

Virtual Communities

The constantly growing body of research on virtual communities as enablers of new explorations and expressions of personal and social life also informs the conceptualization, design, and evaluation of ICE.

There is not a single definition of *virtual community*. This term is used for describing many kinds of Internet-based social interactions. Preece (2000) iden-

tified four high-level characteristics of an online community: (a) people who interact socially to satisfy their own needs and goals and perform special roles such as leading or moderating; (b) a shared purpose, such as an interest, need, or goal that provides a reason for the community to exist; (c) policies in the form of tacit and written assumptions, rituals, protocols, rules, and laws that guide people's interactions; and (d) computer systems to support and mediate social interaction and facilitate a sense of togetherness.

These characteristics refer to two processes that Preece identified as essential when designing, developing, or evaluating virtual communities: sociability, which focuses on social interactions that happen within the community (Donath, 1998); and usability, which focuses on human-computer interaction from a software design standpoint (Nielsen, 2000).

Virtual communities can foster PYD if both sociability and usability are taken into consideration. For example, in the Zora multiuser virtual environment that I describe later, sociability was operationalized by setting up a social framework for groups of preteens and teens with common needs and characteristics (i.e., cultural diversity, medical condition); usability was operationalized by providing design features that would engage children in the design of a virtual city and its social organization and civic institutions to support sociability.

There is a growing amount of research on virtual environments that concentrates on both technical and social characteristics that foster the development of community. For the purpose of providing a theoretical framework for the design of ICE to foster PYD, research on virtual communities for education and for mental health is valuable because of its interventionist nature, and not only its explanatory or descriptive nature.

In the area of education, research has shown that networked learning environments can provide quick access to a wide range of information and resources, as well as communication mechanisms for engaging in collaborative inquiry, critical debate, and communities of practice (Edelson et al., 1999; Pea, Edelson, & Gomez, 1994; Scardamalia & Bereiter, 1996; Songer, 1996). In line with the constructionist tradition, work has focused on the Internet as a medium to support collaboration by providing tools for children to become active builders of their learning communities, not only to grant access to information (Bruckman, 1998; Evard, 1996; Pinkett, 2000; Resnick et al., 1996; Shaw, 1994).

The area of mental health in the last decade has increased the amount of practice and research on uses of technology, such as online support groups, e-mail therapy, and bulletin boards (Bush & Simonian, 2002; Gonzalez-Heydrich et al., 1998; Jones, 1999; Rice & Katz, 2001). Most of the work focuses on analytical

and descriptive aspects of identity in cyberspace (Calvert, 2002; Suler, 1996; Turkle, 1995). Building on the technical infrastructure of distributed virtual environments, or multiuser virtual environments, online communities can enable new expressions of psychological and social life by providing software that supports conversations, collaborations, and interactions (Kollock & Smith, 1996; Morningstar & Farmer, 1991; Rheingold, 1993; Waters & Barrus, 1997).

In summary, the concept of ICE is strongly nurtured by research on virtual communities, specifically in the areas of education and mental health. The challenge is how to evaluate and study the design of these environments and social contexts to support exploration of issues of identity that bridge into children's offline "real lives" and that can play a positive role in their development.

Narrative Theories

The use of narratives in ICE is inspired by the positive uses of storytelling in both educational and psychotherapeutic interventions (Coles, 1989; White & Epston, 1980). Narrative has become a tool that is highly utilized to teach and learn about personal values and to understand moral development (Tappan & Brown, 1989). It has a long and universal tradition in programs aimed at moral and character development education. Stories such as fairy tales or myths, and biographies of historical and religious figures, are used to introduce universal human values and role models to children (Bennett, 1993).

Johnson (1993) indicated the importance of a narrative context to fully understand moral personality (the self) and its actions. *Narrative*, or the ability to tell a coherent story out of fragments, plays a major role in integrating the plurality of coexistent "disparate selves" acquired from others (Gergen, 1991). This refers to the descriptive function of narrative with respect to identity formation that supports the finding of coherence between the diverse internalized role models and stories of our experience, thus allowing us to have a coherent life story to present to others and to ourselves (Linde, 1993). The descriptive function is embodied in self-description genres such as conversational personal stories (Miller et al., 1990) and autobiographies, and it allows the organization of the facts after they occurred. The constructive function of narrative enables us, through external dramatizations, to play out our inner chorus of internalized voices and diverse roles in the world.

Narratives operate at three different, vital levels: cognitive, emotional, and social. At the cognitive level, narratives are fundamental constituents of human memory that provide a distinctive way of ordering and understanding experience (Bruner, 1986; Schank & Abelson, 1995). At the social level, the tales that one

knows and can tell define the social group or culture to which one belongs (Turner, 1981). Myths, legends, and traditional tales provide a sense of continuity between generations as well as models for human behavior (Campbell, 1988). Finally, narratives play an important emotional function. As Anna Freud (1965) and the growing field of narrative therapy have shown, through the verbal-play or the writing experience of storytelling, people can find not only recreation, but also self-cure (White & Epston, 1980).

In sum, from cognitive, social, and emotional standpoints, it is important for young people to have a place to tell their stories and to construct their sense of self. Thus, the use of narratives and their underlying theoretical bases are key elements that inform the design and study of ICE to foster PYD. Virtual environments are also powerful tools for supporting people to tell their stories, both individually and in the context of a community that provides an audience for those stories (Bers, 2003). As we see later, the different types of ICE presented in this article offer multiple and diverse ways for individual users and communities to engage in storytelling.

ICE

This article identifies two types of ICE specifically designed to promote PYD: technological tools and technologically rich environments (see Figure 1). Both types are built on the 10 design guidelines described earlier.

The first type of ICE refers to a computational tool, a piece of software or hardware, or a combination of both that meets certain design specifications and technological standards. Although nowadays many computational tools exist, such as the software packages or the networked applications we use daily for work, entertainment, and education purposes, not all of these products are specifically designed with the goal of fostering PYD. In this article, I present an example of an ICE of this type (i.e., a purposefully designed computational tool), the Zora multiuser virtual environment. This kind of ICE does not need to be used with an external curriculum to foster PYD; the ICE's design features are such that the PYD curriculum is embedded in the technology. Of course, a powerful curriculum will make the use of this type of ICE even more successful.

The second type of ICE refers to technologically rich environments, psychoeducational programs, and interventions that provide either a face-to-face or a virtual context that use already existing technologies. These technologies might have been initially developed with other goals in mind, but, in these environments, are integrated with a positive development framework. Thus, the curriculum and context in which the technology is used is crucial and needs to

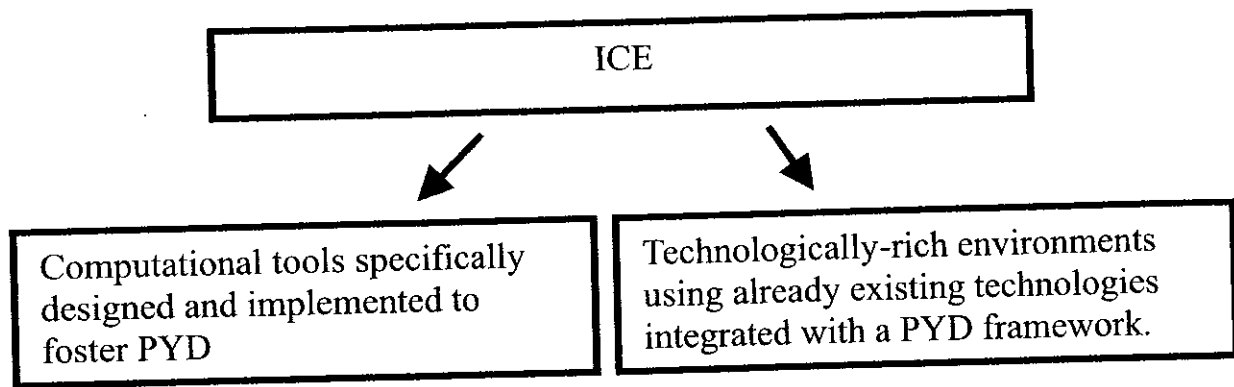


Figure 1. Two types of identity construction environments.

have a strong PYD component. An example of this is Project Inter-Actions, which is described later in this article. Project Inter-Actions uses the Lego Mindstorms kit and the Robolab programming language originally developed to teach children about math and science through robotics and integrates them into a curriculum specifically designed to explore issues of identity, culture, and family relationships. The overall curriculum of the technologically rich environment meets the ICE's design guidelines described earlier, and the chosen technology, within this context, serves to promote PYD.

The method for designing and evaluating ICE is based on the creation of a matrix in which each C of PYD corresponds with design features of the technology that afford activities for learners (i.e., Curriculum) and that are evaluated with research instruments to measure the success of the ICE regarding that particular PYD component. In the following sections, the article presents that matrix in the form of tables for both the Zora virtual world and Project Inter-Actions. These are only two examples, and the overall goal of this article is to show how the same type of work could be done for any other popular technology available and widely used by today's youth. If the technology meets most of the 10 design characteristics of ICE (this process assures the user that the software has design features that promote PYD), then a curriculum could be developed to integrate the technology into a PYD program.

An ICE Technology to Foster PYD: The Zora Virtual World

The Zora computational tool, initially developed as part of Bers's doctoral dissertation at the MIT Media Laboratory, was specifically designed for fostering PYD (Bers, 2001). Zora is a three-dimensional, multiuser, virtual environment² that provides tools for

end users to design and inhabit a virtual city. These tools are easy to use and were designed with a young population of users in mind. Children can populate the virtual world by making their own interactive creations. They can design objects, characters, and spaces, as well as a virtual community in which personal, moral, and community values are put to the test. Avatars with the owners' image represent users in the virtual space. An avatar construction kit allows users to design their own avatars to navigate the virtual city and converse through a graphical chat system (see Figure 2).

Because exploration of personal identity is a major component of the experience, Zora users can create their own pictures and objects representing aspects of the self or import them from an existing graphical library. Users can create four different types of Zora objects: *virtual places* (private homes, public and community spaces), *objects* (picture frames, furniture, cases, bulletin boards, etc.), *heroes*, and *villains* (i.e., models of identification and counteridentification). In Zora, objects have properties that, besides defining their shape and functionality, also specify the meaning or personal and moral values that people assign to them. One of Zora's distinguishing features is a *values dictionary*, a compendium of personal and moral values, and their multiple definitions, held by the Zora community.

Zora's overarching design goal is to promote PYD by providing tools and opportunities for developing the six Cs. Therefore, it has specific design features that were conceived to investigate and operationalize each of them. The following table shows, for each of the six C components of PYD, the Zora design fea-

²In a graphical multiuser environment, several users can interact with each other in real time via the Internet. Users feel immersed in an artificial space containing representations of data, programs, and other users.

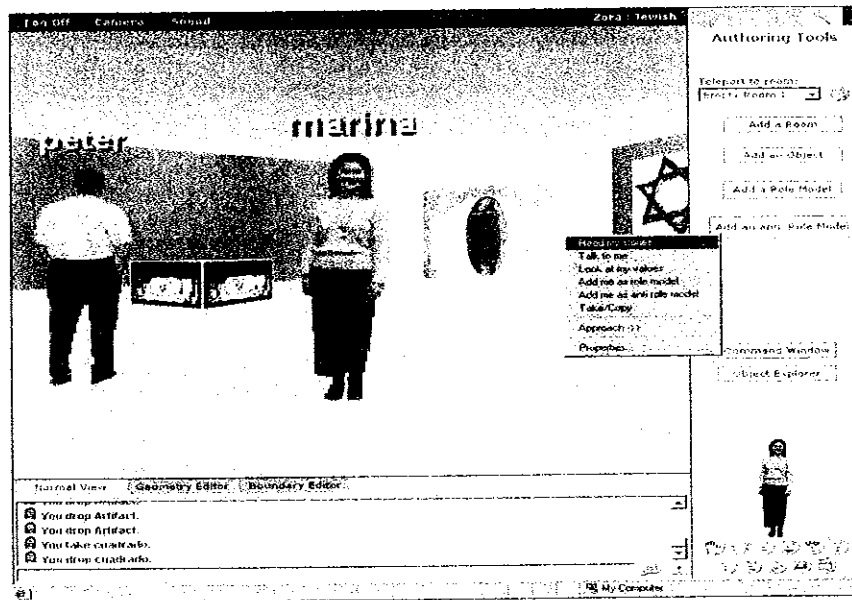


Figure 2. Zora's interface and an avatar.

tures and the online activities they support (see Figure 3).

Pilot Studies With Youth Using Zora

Two different pilot studies were conducted using Zora—one with young patients and medical staff in the Dialysis Unit at Boston's Children's Hospital (Bers, Gonzalez-Heydrich, & DeMaso, 2003) and another with a multicultural group of preteens and teens in the context of a summer camp (Bers, 2001).

I do not describe these studies in depth in this article, nor do I present data to address how young people in need of exploring issues of identity used Zora to design a graphical virtual city and its social organization because that data are already published elsewhere (Bers, 2001; Bers et al., 2001, 2003). Instead, I compare and contrast these experiences, drawing on

results that could be generalized to similar studies, and I present a selection of examples from both pilot studies that support the theoretical framework of ICE presented in this article.

Because ICE such as Zora provide tools for users to become designers, each population that uses Zora can create different virtual cities and can have different kinds of virtual and face-to-face interactions. As is describe later, the fact that two very different populations (i.e., chronically ill children and youth in need of exploring multicultural issues) were able to use Zora to serve their own needs with respect to identity formation shows the flexibility and the potential of ICE.

Both populations were chosen to use Zora because of their need of exploring issues of identity and community. For example, although the pediatric patients undergoing dialysis spend approximately 12 hr a

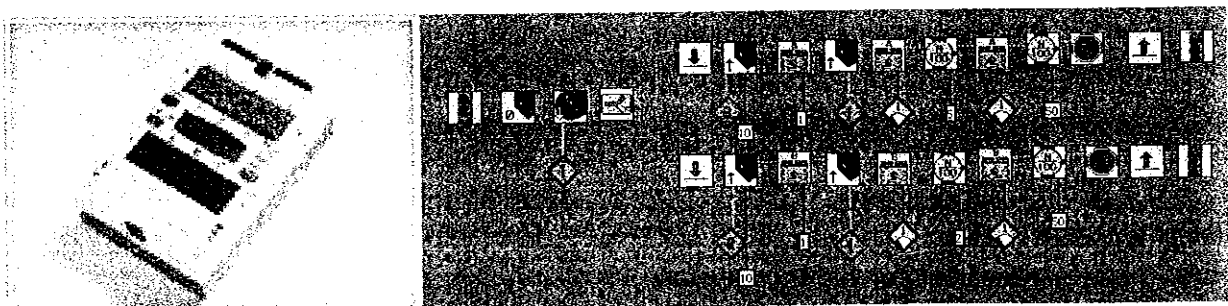


Figure 3. The Lego programmable brick and the icon-based RoboLab program.

week in the same hospital room and share similar conditions and concerns, they cannot communicate with each other in a private way. The dialysis room is a big, noisy environment, and beds are far apart from each other, thus our choice to use Zora with this population. The second population, a multicultural summer program for immigrant youth, was chosen because these youth signed up for the program because they stated in their application materials their desire to explore their backgrounds and values. Because Zora was specifically designed for this purpose, this population turned out to provide an excellent test bed for evaluating if Zora was accomplishing its goals and how.

In the hospital pilot study over a 5-month period, seven hemodialysis patients and four unit staff (7 to 16 years old) found Zora enjoyable and safe. On a 7-point Likert-type scale ranging from 1 (negative) to 7 (positive), the overall patient satisfaction was high ($M = 5.3$, $SD = 1.3$), as was their enjoyment ($M = 5.7$, $SD = 1.6$) in using Zora. The patient safety rating was high ($M = 5.9$, $SD = 1.8$), while patients' rating of harm was low ($M = 1.4$, $SD = 1.1$). The hemodialysis staff's ratings of satisfaction ($M = 6.5$, $SD = 0.5$) and safety ($M = 5.6$, $SD = 1.4$) were high; their rating of level of harm ($M = 1.0$, $SD = 0.0$) was low. The nurses found that Zora did not interfere with their medical routine (Bers, 2001; Bers et al., 2001, 2003). Young patients were reported to use Zora to escape the harshness of the dialysis experience by immersing themselves in a fantasy world (Bers et al., 2003). For example, they created a music temple and a renal rap room, as well as personal homes populated by favorite cartoon characters. In using Zora, they said that they were able to see themselves in new ways, as active learners in control of virtual situations and not as passive patients. Patients also used Zora to create community spaces about their shared medical condition. For example, the Temple of Feeling Better was a virtual space to share stories about coping with hospitalization. Results from this pilot study show the potential of virtual environments such as Zora, designed within the principles of ICE, to foster positive interactions between young people. The limitations of this pilot study are primarily due to the low number of participants. In future studies, however, this can be addressed by connecting several pediatric hemodialysis units so that more pediatric patients can use Zora at the same time and form a larger community.

In the second pilot project, a group of 12 children between the ages of 11 and 15 years old participated in the Zora summer workshop for a period of 16 hr over 3 weeks. They had to complete a selective application process to obtain a self-selected, highly motivated group. It was made clear to them that the goals of the workshop were "learning about computers as

well as exploring issues about youth identity." The selection process favored diverse cultural and religious backgrounds and gender balance, as well as the quality of the submitted biographies.

The participants in the summer workshop chose to focus on the personal and moral values carried by the objects and characters they placed in their virtual homes and public spaces. These spaces resulted in carefully crafted spatial representations of identity. For example, children built a Jewish temple; a Latino house; a Christian Church; and personal homes populated by pictures of family, friends, and pets, as well as pictures of personal objects with sentimental value such as jewelry and clothes. Navigating through these spaces, one gets the sense of who the owners are in real life. One can learn about the children's cultural and religious background, their family life, and their personal interests. As reported in videotaped interviews, participants made an effort to bring to the virtual world cherished artifacts from their real lives. Although the Zora experience of this group was shorter than the study at the hospital, participants created an overwhelmingly greater number of virtual places, objects, and characters (430 during the summer workshop vs. 159 in the hospital experience; Bers, 2001).

Both populations in the studies created a participatory microcommunity. In the hospital experience, young patients and staff created a social support network to facilitate new kinds of interactions and coping mechanisms. The participants in the summer workshop created community spaces to explore issues of social organization and self-regulation. For example, they created a virtual City Hall and voted for the laws of their virtual city. They also experimented with the creation of a virtual jail. They used the space to discuss controversial cases that gave rise to heated discussions about ethical and moral issues.

In this summer program, there was no adult mentor or teacher coordinating the online Zora activities, nor was there a previously planned curriculum. Because the presence of an adult with background knowledge about this area who would behave as coach or guide would bias the results, it was consciously avoided (Bers, 2001). One of the goals of this pilot experience was to observe to what extent an ICE with design features informed by PYD, such as Zora, would engage youth in the exploration of self.

As shown before by the type of activities and discussions that youth self-initiated while using Zora, given the right tools (i.e., software with design elements that promote PYD), it is possible to motivate young people to use technology to engage in positive exchanges and experiences that will strengthen their already existing assets. This has implications not only for evaluating Zora, but for the design and use of commercially available software with the goal of fostering PYD.

Although the long-term goal of the empirical research program I am proposing will evaluate if youth who use Zora, or other ICE, engage in the development of the six Cs of PYD, in these first pilot experiences the goal was to understand the potential benefits of the technology by evaluating how children used it and how successful its design features were in eliciting a certain kind of participation. Therefore, in the same spirit as the ethnographer who immerses him- or herself in a village to understand how its inhabitants live and think, I immersed myself in the Zora virtual cities before, during, and after the studies to try to understand how the environment was used. To avoid what Papert called "technocentric questions," the evaluation was centered on what young people did with Zora and not what Zora did to them (Papert, 1993).

In the following sections, I give a sample of the experiences gained by participants in both pilot studies using Zora, organized by category or component of PYD.

Competence: Developing Technological Fluency by Using Zora

In the literature on PYD, competence involves cognitive and behavioral skills competence in interacting successfully socially and, in addition, the ability to keep oneself healthy and fit (Lerner et al., 2003). In the framework proposed here, competence also refers to the development of technological fluency. This construct was first introduced by Papert (1980) in referring to the ability to use and apply technology in a fluent way, effortlessly and smoothly, as one does with language. It involves not only mastering technological skills and concepts, but also the ability to learn new ways of using computers in a creative and personally meaningful way. During the process of using the technology in a creative way, people are also likely to develop new ways of thinking; therefore, the computer's role goes far beyond being an instrumental machine.

By using Zora, young people in both studies developed competence by mastering a rich set of computational tools to become designers and programmers of their own computational projects. For example, all of the participants learned to design a three-dimensional virtual space and to calculate vertical, horizontal, and depth axes to locate their objects. They used complex graphic tools and computer-related equipment such as digital cameras and scanners. They also learned how to program and debug simple interactions for their objects by using a conversational programming language based on the turn-taking metaphor (Bers, 2001, 2003; Bers et al., 2001).

Youth became empowered by becoming technologically fluent. Over time, they were able to approach new software and equipment without top-down in-

struction. They played with new tools and were able to transfer previous knowledge to new situations. For example, in the summer workshop, children learned how to manipulate their avatars and virtual rooms. They became comfortable enough with the technology to push its limits in a creative and responsible way. During the hospital experience, becoming technologically fluent helped the young patients gain a different kind of self-image. They saw themselves as powerful learners in active control of their computers, if not of their bodies. They also found themselves in the role of experts, teaching nurses and hospital staff about technology. Also, as some of the patients expressed in the exit interviews, they used their time on dialysis to develop some of the skills and knowledge that they did not acquire at school, because they either had to miss many classes due to the medical treatment or had already dropped out of school altogether.

Connection: Forming a Virtual Community

Sherry Turkle's (1995) pioneer work has shown that computer-mediated communication and participation in online communities can play a positive psychotherapeutic role. Turkle's findings were replicated in my own pilot studies conducted with Zora, by observing that youth were able to establish connection with peers, with adults in their worlds, and with institutions by forming a virtual community. In the hospital study, although patients share a medical condition and treatment that makes them and their lifestyles different from that of other young people their age, two factors hinder the formation of a community in which social support networks and patient interaction can fully develop. First, patients are on different dialysis schedules. Therefore, they do not always know each other and/or have the chance to interact. Second, although some patients spend many hours together in the same room, they cannot communicate with each other in a private way while in treatment. The dialysis process ties them to unmovable beds that are too far apart physically to allow adequate social conversations.

The Zora ICE, however, enabled patients to solve these problems and connect with each other. It also allowed them to connect at a different level with hospital staff, beyond the strictly medical interactions. For example, many patients became experts on the technology faster than the adults and were able to play the role of mentors and teachers for the nurses and medical staff participating in the study (Bers et al., 2003).

To facilitate connection, Zora provided both synchronous and asynchronous ways of communicating and sharing experiences. On a 7-point Likert-type scale ranging from 1 (negative) to 7 (positive), patients reported that using Zora helped them make friends or

get support from other children on dialysis in a moderate way ($M = 3.86, SD = 2.41$). At the same time, they reported that it greatly helped them to feel more part of a group on dialysis ($M = 4.43, SD = 1.62$). Hospital staff perceived that using Zora helped patients to make friends ($M = 4.50, SD = 1$) and to feel part of a group ($M = 3.75, SD = 0.5$; Bers et al., 2003).

Most of the patients particularly liked the fact that Zora provided a good way to communicate with each other in a private way while undergoing the public event of dialysis. A 13-year-old patient said,

I really liked that I could use Zora to talk to other kids who were at a distance. Otherwise I would have to yell across the room. But using Zora was great because others could not eavesdrop on my conversation and I felt more comfortable discussing things. I particularly liked to talk with others about our favorite nurses, without being heard.

Patients also used Zora to post messages in each other's message boards and to write stories for their virtual objects and characters. This asynchronous way of communicating their feelings facilitated the creation of a social network by providing a space for patients to voice their opinions and to engage in interactions with medical staff without the burdens of face-to-face and real-time conversation.

Character: Developing a Sense of Personal and Moral Values

As mentioned earlier, Zora has many design features specifically aimed at helping children explore and develop integrity of character and a moral compass. The nature of an ICE as a safe space lends itself to engage in experimentation with issues of character. For example, youth can write personal and moral values and associate them with their objects. They can make role models and antirole models, and they can enter values, and define them, in the collective values dictionary of the city. Issues of character, however, are also observed throughout the Zora experience by the kinds of discussions and situations that participants engaged in.

Zora's design supports two very different ways to learn about personal and moral values. One affords thinking about values as repositories of prescribed beliefs or normative universal principles. This is supported by the design feature of the collaborative values dictionary. This approach is typified by abstract definitions. To create a new value and its definition in the dictionary, learners think about values as universal principles, disassociating them from any specific context or object in the virtual world. This approach is the most common one found in educational interventions where

the use of the Socratic method of discussion about moral dilemmas abound (Lipman, 1988).

Zora also affords a different approach to values in which, instead of focusing on a universal definition, children define virtual objects in terms of their values. Therefore, when a child designs an object, she also has to think about the values that the object conveys and its relationship to her personal identity. During the exit interview, when I asked 15-year-old Nino what he learned during the workshop, he said,

How to see values in things ... because usually when I see something I just see it. I really don't think about it ... this opened my eyes. For example, before I didn't think that there was much value in my Dave Matthew's poster or a picture of me fishing ... I didn't think about values at all. By attaching values to things you realize what your values are and you also make other people more likely to know you better. Right now when I see something, somehow I wonder what values it has, and what certain people think its values are. (Bers, 2001, p. 62)

Most of the youth who worked on Zora chose this concrete way of approaching values (i.e., grounding them and their definitions in objects) instead of the abstract approach (i.e., entering values and definitions directly into the values dictionary). Janet's comment in the postinterview is representative of most participants' opinions:

When I write values for my objects I feel like I can express my feelings and it is a way to see what is going through my mind. I usually don't talk about values and don't think much about them. For example I wrote down something about love and I realized wow! I am really into this but I didn't know because I don't talk about it ... so there was something new for me. When I wrote the values is when I learned a lot more about myself. (Bers, 2001, p. 63)

As shown in this section, the Zora ICE supported the exploration of values in both an abstract and a concrete way. The design and manipulation of computational objects with values attributes provided a unique opportunity for children to think about the relationship between values and their identity and therefore strengthen their character.

Confidence: Learning to Learn

The constructionist nature of ICE, which, in the case of Zora, engages children in becoming designers of their own virtual city and social organization, can foster self-confidence in youth. Although the development of a positive self-regard and a sense of self-efficacy were observed in both studies, no formal measures were used to evaluate this. By analyzing the Zora

logs of online conversations and the videotapes of face-to-face interactions, it is possible to determine that children were not only able to master the technology, but also to help others to master it. Some gained a new sense of confidence in themselves as learners and teachers of concepts and skills that are particularly valued in our society, such as new technologies. Others felt that they were able to complete a project, such as finishing their virtual homes and temples, and were proud to share these products with others.

Confidence could be observed, and quantitatively measured, on the issue of safety. On a 7-point Likert-type scale ranging from 1 (negative) to 7 (positive), patients in the hospital study reported that Zora was safe ($M = 5.93$, $SD = 1.84$) and that participating in the experience was not hurtful ($M = 1.43$, $SD = 1.13$). When asked about the safety of using Zora, 17-year-old Larry replied

It might be unsafe if you put certain things in your room that younger kids shouldn't see. But that's the whole point with having the [virtual] city hall, where we set the rules and laws for Zora. I don't think it's not safe for kids.

In Larry's perspective, it was the patients' responsibility to make Zora a safe space. His response shows self-confidence regarding the responsibility assumed toward safety by the individuals, as well as by the community as whole. Overall, all patients echoed Larry's response by reporting that Zora was safe because it provides tools for them to set their own safety net by developing laws and rules for community participation and democratic decision making (Bers et al., 2003).

Caring: Forming a Just and Empathic Virtual City

ICE such as Zora are designed to foster a caring community by having specific design features to engage individuals in developing a sense of empathy. This kind of design considerations are widespread in the literature on virtual communities (Kollock & Smith, 1996). For example, in Zora, a "legacy" object engages youth in posting advice for future Zora users at the entrance of the virtual city. Data from both studies show that legacies tend to fall into three categories—those giving advice about technical issues, about how to design expressive artifacts and places, and about how to handle social issues in the community.

The notions of social justice and human values empathy were mostly shown in the virtual City Hall that provided a public forum for participatory democracy and decision making about authentic dilemmas faced by the Zora community and society at large. For example, during the summer workshop, Elisa, who built a virtual Jewish temple, placed in City Hall a case with a

Web link to a news article about a shooting in a Jewish Community Center in Los Angeles that had happened the day before. She attached to it the value "tolerance" and defined it. Some children decided to invite everyone to a virtual meeting to discuss the news. In this very well-attended meeting, children explored the notions of social justice, discrimination, and racism. As a result of this conversation, one of the youngest participants in the workshop, who was very quiet "listening" but who did not participate in the online conversation, made in Zora "Everyone's temple." He described it as a space for "all the cultures and religions to get along" (Bers, 2001, p. 55).

In Zora, children were able not only to talk about social justice, but also to act on it in the virtual world. Therefore, Zora was successful in supporting the passage from knowledge to action, one of the 10 design guidelines for ICE to promote PYD.

Contribution: A Safe Space for Engaging in Civic Life

Although some research on PYD considers that the ability to contribute to civil society is the result of actively developing the other five characteristics—Competence, Confidence, Connection, Character, and Caring (Lerner et al., 2003)—in my own work, the orientation to contribute to civil society is considered an important characteristic on its own merit.

ICE have particular design features explicitly conceived to help children become active contributors to civil society. Virtual communities, such as the ones afforded by the Zora ICE, provide a safe space for experimenting with decision making, self-organization, and civic conversations, as well as for testing democratic values, behaviors, and attitudes in an authentically meaningful way. For example, the notion of a "case," an object representing an event or circumstance to be discussed and agreed on by the community members, was introduced in Zora to help children base their online conversations on concrete artifacts. In the same spirit as legal cases, they require community members to take action to resolve them. This kind of participation in a learning environment serves as a model of the larger political community in which the child will participate as an adult. For example, in Zora's City Hall, youth created different kinds of cases. Most dealt with setting up the social organization of the virtual city or with controversial current events reported in the newspaper.³

³In the summer workshop reported in this article, I took a child-centered perspective; therefore, the only cases to be discussed were those created by the young participants. In a different type of experience, however, where the teacher or facilitator has a more active role, it might be interesting to seed the Zora virtual city with controversial cases to foster debate.

In the second week of the workshop during the summer pilot study, participants discovered the need to create laws to make living in Zora easier. This realization happened as learners started to try out different Zora features and test its technical limits. For example, when they created huge objects and left them in inadequate virtual places, they learned how to distort the look of personal avatars and how to change the size of other people's personal homes (Bers, 2001). In contrast with other experiences of just-community in education (Kohlberg, 1982), the idea of creating laws emerged in a natural way, as a need of the community and not as a suggestion from an external agent such as a teacher or facilitator. In the first City Hall virtual meeting, a city mayor was elected and took charge of coordinating the writing of the rules of Zora. Participants also experimented with different online voting systems.

Zora makes it easy for youth to observe the connections between what is said in the online conversations (i.e., discussion about discrimination) and what is done in the virtual city (i.e., creating "Everyone's temple"). The discussions occurring in City Hall offered participants an opportunity to engage in thoughtful exchanges with people with different opinions who made their values clear through their virtual creations. According to most of the workshop participants as reported during exit interviews, being online helped them to discuss certain issues in more depth than when face to face. This finding is consistent with results from other researchers working with virtual communities and youth (Turkle, 1995). It was also informally observed, however, that some conversations that started online were continued offline. Future studies need to assess to what degree the online experience can transfer to the real face-to-face communities.

An ICE Context for Using Technology for PYD: Project Inter-Actions

The pilot work with Zora shows how the first type of ICE—a computational tool with specific design features that correspond to the six Cs—might help to promote PYD in two different populations of young people. The second type of ICE presented in this article refers not to software such as Zora, but to an approach that applies the PYD framework to a technologically rich environment in which children are using technologies that were originally developed with other goals. Project Inter-Actions is an example.

In this research program, young children and parents come together to explore their own cultural heritage by engaging in designing, programming, and building a personally meaningful project: a robotic artifact that can move and react to stimulus from the world. This robot represents an aspect of their own personal, family, or cultural values (Bers, New, & Boudreau, 2004).

The technology of choice during Project Inter-Actions is Lego Mindstorms, a commercially available robotics invention system inspired by the MIT Media Lab's programmable brick (Martin et al., 2000). The toolkit enables children to work with manipulative material that they are already familiar with, such as Lego blocks. But they can also incorporate motors and touch, light, or motion sensors. Later, they can program the behaviors of the "smart" Lego brick by using a graphical programming language called ROBOLAB (Rogers, Kearns, Rogers, Barsosky, & Portsmouth, 2001; see Figure 4).

Three different pilot studies within Project Inter-Actions were conducted. The first study was done in a Jewish Day School in Buenos Aires, Argentina, in which families made robotic creative prayers



Figure 4. A doll with two hands ready to give and receive.

and shared them with other members of the community at the synagogue right before the traditional prayers of the Jewish high holidays (Bers & Urrea, 2000). The second pilot study was done with families of 4- and 5-year-old children from the Eliot-Pearson Children's School and the Tufts Educational Day Care Center (Bers et al., 2004). The third study was conducted with 80 families in the context of weekend workshops for the greater Boston-area community (Beals & Bers, in press).

Regardless of the specific differences between the three studies, all of them followed a same pedagogical approach consistent with the 10 characteristics of ICE described earlier. Workshops were intensive. They consisted of five sessions of 2 hr each, during which families were taught how to use the technology, and a final open house to display final projects to friends, family, teachers, and other community members. The workshop sessions followed a project-based immersive method. Families were involved in all aspects of the project—they chose the culture to explore, decided which materials to use, managed the resources and time frame, resolved the technological challenges (both in terms of programming and mechanics), created narratives around the final project that were posted in a Web site documenting the experience, and presented their final projects during an open house.

Each family received a computer and a Lego kit containing the essential components needed to build a robotic project. On one table, there were various art materials, such as construction paper, markers, colored pencils, crayons, felt, buttons, glue, straws, and so forth to be used either in the planning stages or on their actual projects. On another table were bins of Legos—beams, plates, bricks, wheels, connectors, and so forth. The placement allowed the families to take whichever materials they desired for maximum creativity, but also to engage in negotiations that would foster a sense of a caring community.

An important component of Project Inter-Actions is the "technology circle." Throughout the course of each session, everyone would gather in a circle for informal presentations. Participants would show their projects, regardless of the stage that they were in, and talk about what they were making, what inspired them, problems they encountered, and so forth. Other families could ask questions or provide help from their own experiences. These presentations were important to show different design strategies completed by each family. Families documented their projects and their learning process in the project Web site: http://www.ase.tufts.edu/devtech/Project_Inter-Actions/.

Children and parents were not expected to master the same programming and building skills. Rather, the goal was to expose them to a technology-rich environment with diverse expertise and interests so that

they might form a community of practice (i.e., doing things with the technology) to develop technological fluency and, at the same time, start to develop the six C components of PYD (Lave & Wenger, 1991).

In the same spirit as the apprenticeship model, in which at first learners have legitimate peripheral participation and later on gradually increase their engagement and complexity of participation (Lave & Wenger, 1991), Project Inter-Actions provided an environment for both children and adults to participate in a community of practice in which technology and cultural issues come hand in hand.

To show how Project Inter-Actions' design features and curriculum correspond to each of the six Cs of PYD and to the guiding design principles of ICE, the same matrix that was used earlier for analyzing Zora is presented here, but for Project Inter-Actions (see Figure 5).

In the following subsections, I present some of the participants' experiences in the three studies conducted to date within Project Inter-Actions, organized by category or component of PYD. Table 1 shows the mean difference between post- and prescores regarding each of the components of PYD (except Contribution) for parents and children who participated in the last study conducted within Project Inter-Actions.⁴ The scores were obtained from self-report questionnaires. Table 1 also shows standard deviations and the corresponding *p* values for the paired *t* tests. Results are presented for parents and children separately.

Competence: Developing Knowledge About Robotics

Daughter: I am making a Lego cake, it is going to spin around. My mom helped build it at home and Barbie helped too. She told me how tall to make it ... I like the building part of this class but I don't like the computer and waiting part. It takes too long. It's really hard for me. Right mom?

Mother: It was hard for her to use the program. I have to help and go really slow so she can do it. In my job I do web design. But I don't know Legos at all. Her father usually plays with them, so I have limited experience using them. Here she teaches me about them.

The previous dialogue captures some of the ways in which both adults and children started to develop competence and technological fluency through Pro-

⁴Data from surveys were only obtained in the third study conducted within Project Inter-Actions. The first two pilot studies were exploratory.

PYD Component		Definition	Zora's Design Features	Afforded Activities
Competence	Technological Fluency	Ability to use and apply technologies in a fluent way to create projects, communicate and express oneself	<ul style="list-style-type: none"> • Authoring tools • Programming environment 	<ul style="list-style-type: none"> • Multiple modes of interaction (synchronous, synchronous, textual, graphical) • Youth as designers and programmers
	Connection	Having and maintaining good relationships with peers and adults (health care professionals)	<ul style="list-style-type: none"> • Communication • Virtual spaces • Support group 	<ul style="list-style-type: none"> • Support network • Decision-making, self-organization
	Character	Personal integrity, possessing a moral compass that effectively guides behavior	<ul style="list-style-type: none"> • Heroes and villains • Values dictionary • Values • Virtual spaces • Narratives 	<ul style="list-style-type: none"> • Introspection • Abstract values and concrete definitions • Models of identification • Perspective taking • Representation identity
	Confidence	A sense of oneself as a person who can act successfully	<ul style="list-style-type: none"> • Communication • Zora's creations and participation over time 	<ul style="list-style-type: none"> • Programming interactions for objects • Overall Zora experience
	Caring	Having compassion and willingness to respond to needs and concerns of other individuals	<ul style="list-style-type: none"> • Communication • Virtual spaces • Cases 	<ul style="list-style-type: none"> • On-line interactions • Community building
	Contribution	Orientation to contribute to civil society	<ul style="list-style-type: none"> • Communication • Virtual spaces • Values dictionary • Cases 	<ul style="list-style-type: none"> • Decision-making, self-organization • Community building • Participation • Discussion

Figure 5. This shows, for each of the six Cs of PYD, the Zora features and the online activities they promote.

ject Inter-Actions. According to the self-assessment of a technological fluency scale completed by participants before and after the studies, and to the teacher's assessment of their process and their final robotic products, most young children understood the basic principles of programming (i.e., algorithms, looping, debugging) and the basic principles of engineering (i.e., the design process, force, sensors, motors). Table 2 shows adults and children perceived competence with regard to building a robot, programming the computer, and building with Legos after the workshop.

As reported by the teachers, children were creative in solving problems by constructing a model of the proposed solution for testing purposes. All children were able to have a working final product and to explain its design process and its way of operation. Besides the actual learning about the technology, children also developed self-confidence in their capabilities to learn new technologies and to approach new difficult problems. For example, there was a significant increase in both par-

ent's and child's self-perception on competence. However, the change was dramatically higher for children (parents M difference = .24, $p = .04$; children M difference = 1.18, $p < .0001$). Our observations and interviews, as well as assessment of the robotics final projects, support this finding.

Connection: Families Learning Together

One of the main goals of Project Inter-Actions was to provide a technologically rich environment in which parents and children could connect with each other in a different way from what they are used to at home. During all three studies, we observed that different families had different collaborative working styles, some more effective than others. For example, some parents initiated and directed their work together, whereas others put the child in charge, and some parent-child dyads seemed to enjoy taking turns being in charge of their work together.

Table 1. Scores on PYD Components for Parents and Children Participating in a Study Within Project Inter-Actions

	N	M Dif ^a	SD	p ^b
Adults				
Competence	37	0.24	0.48	.0046
Confidence	37	0.14	0.54	.1129
Character	37	0.08	0.68	.4739
Connection	37	0.16	0.45	.0363
Caring	37	-0.05	0.86	.7059
Children				
Competence	37	1.19	0.69	.0000
Confidence	37	0.43	0.52	<.0001
Character	37	0.73	1.56	.0072
Connection	37	-0.35	1.00	.0416
Caring	36	0.11	1.14	.5627

Note: PYD = positive youth development.

^aM dif = mean score after the workshop–mean score before workshop. ^bPaired *t* test.

Parents significantly increased their connection score after the workshop (*M* difference = 0.16, *p* = .04), whereas children decreased their score (-0.35, *p* = .04). This result is consistent with the workshop coordinators' evaluations that stated that they observed many interactions of parents collaborating, competing, or helping each other, whereas they observed very few interactions between children. Children tended to become so immersed with the materials that limited their interactions to their parents and sometime teachers.

It was not easy for all of the parent–child dyads to become comfortable with each other in new roles as both teachers and learners. In most of the cases, it was the parents, and not the children, who had the most difficulties adjusting to this. In some cases, it was anxiety provoking for a parent to have to learn something new and, at the same time, help his or her child with his or her own learning. This was true regardless of the level of comfort that parents had with technology. For most of the parents, this was an opportunity to spend time with their children doing something together. The same was true for the children, who enjoyed the chance to have their parent's devoted attention.

The community of practice methodology applied in Project Inter-Action fostered connection not only be-

tween parents and children, who engaged in a teaching and learning experience together, but also among diverse families. The technology circle explicitly facilitated these kinds of interactions aimed at helping people connect with each other, regardless of age or skills level.

Character: Robots That Represent Values

By making a final product that explicitly represents the family's personal or cultural values, parents and children were immersed from the beginning of the workshop in an environment in which issues of character were openly discussed. For example, during the study done in Argentina (Bers & Urrea, 2000), one family chose the value "giving and receiving," and the young daughter explained the project (see Figure 6):

We made a doll with two yellow hands and every time you give her a present in her hand, she turns around and gives you something back with her other hand. But you don't know what she is giving you. There are smiles, flowers and hugs in her second hand and you can receive anything. (p. 201)

Table 2. Adults and Children Perceived Competence After the Workshop

	N	M Dif ^a	SD	p ^b
Adults				
Building with Legos	37	-0.05	0.66	.6237
Programming	37	0.48	0.73	.0002
Making robots	37	0.86	1.13	.0000
Children				
Building with Legos	36	-0.08	0.87	.5710
Programming	37	1.67	1.45	.0000
Making robots	37	2.54	1.04	.0000

^aDif = score postworkshop–score preworkshop. ^bPaired *t* test.

PYD Component		Definition	Project Inter-Actions Curriculum	Afforded Activities	Measures
Competence	Technological Fluency	Ability to use and apply technologies in a fluent way to create projects, communicate and express oneself	<ul style="list-style-type: none"> • Designing (engineering design process) • Building (engineering concepts) • Programming • Web design 	<ul style="list-style-type: none"> • Youth as designers, builders and programmers • Youth as creators of their project's home pages 	<ul style="list-style-type: none"> • Technological confluency scale • Teacher's technological fluency assessment • Content analysis of designing, building and programming process
	Connection	Having and maintaining good relationships with peers and adults (health care professionals)	<ul style="list-style-type: none"> • Brainstorming about culture • Choosing a project • Working together on the project 	<ul style="list-style-type: none"> • Parents and children working together • Families the context of a community of practice • Technology circle 	<ul style="list-style-type: none"> • Technological confluency scale • Teacher's assessment • Designing, building and programming • Interviews • Video analysis • Observations
	Character	Personal integrity, possessing a moral compass that effectively guides behavior	<ul style="list-style-type: none"> • Exploration of values • Creation of narratives for the artifact 	<ul style="list-style-type: none"> • Discussions during the design process • Discussions • Web site creation 	<ul style="list-style-type: none"> • Content of final products • Technological confluency scale • Self-reports of work at home • Observations
	Confidence	A sense of oneself as a person who can act successfully	<ul style="list-style-type: none"> • Communication within and between families • Final working product 	<ul style="list-style-type: none"> • Discussions • Technology circle • Design, creation and programming 	<ul style="list-style-type: none"> • Technological confluency scale • Observations • Video analysis • Interviews
	Caring	Having compassion and willingness to respond to the needs of other individuals	<ul style="list-style-type: none"> • Communication within and between families • Technology circle 	<ul style="list-style-type: none"> • Technology circle • Design, creation and programming 	<ul style="list-style-type: none"> • Technological confluency scale • Observations • Video analysis • Interviews
	Contribution	Orientation to contribute to civil society	<ul style="list-style-type: none"> • Communication within and between families • Diversity of projects 	<ul style="list-style-type: none"> • Community building and self-organization • Community of practice 	<ul style="list-style-type: none"> • Technological confluency scale • Observations • Final projects • Web sites analysis • Interviews

Figure 6. This shows, for each of the six Cs of PYD, the Project Inter-Actions features and activities and the general measures used in the studies. The measures mentioned in this table can be found in Lerner et al. (2005), Bers et al. (2003), and Bers et al. (2004).

Children showed a statistically significant increment in the character construct, being aware about their own moral compass and values (M difference = 0.7, $p = .007$), after participating in the workshop. This was not the case for parents. This result was expected, because parents played scaffolding and supporting roles to help children explore aspects of their own values. Parents were not intended to engage in their own value clarification, but in conversations that would teach something they already knew to their children.

Character development was also observed by teachers as the young children in the project became respectful participants and followed the established

community rules. They also discovered the importance of values such as perseverance. Throughout Project Inter-Actions, teachers encouraged their students, both adults and children, to share resources, ideas, and projects with each other as well as to provide peer-support in the same spirit of a community of practice.

Confidence: Being Proud of Learning

As mentioned earlier, one of the goals of Project Inter-Actions was to immerse families in an environment where they could begin to develop technological

fluency in a confident way. We did not expect them to become programmers or engineers. Both children and parents were more confident after the workshop, but the change was statistically significant in the children (parent M difference = .14, $p = .11$; children M difference = 0.43, $p < .0001$). In one of the studies, a mother said,

I am proud of what we made ... my children solved the issues we had with our design. I really tried to get them to do the thinking and kept asking them questions. My son is proud of how he was able to program our project. My daughter is very proud of the project because she likes the bunny and how it moves and picks up the basket she made. She grasped some of the technological concepts of the project such as the motor connection, the "wire" connection when programming and how the program had to be downloaded to the brick.

These 4-year-old children mastered some technological skills, but most important, they were proud of themselves, as was their mother. As these children grow and longitudinal studies are conducted, we will be able to observe whether these early experiences with a culture of learning about technology in a playful way might have long-lasting effects in helping children become confident users and creators of technology, as well as confident learners.

Caring: A Collaborative Learning Environment

Throughout Project Inter-Actions, caring was shown by the propensity of both adults and children to help each other in the different design, programming, and building stages of their projects. As opposed to most robotics educational experiences (Rogers et al., 2001) in which children are exposed to learning about the technology by engaging in challenges and competing with each other, Project Inter-Actions curriculum is explicitly designed to foster a learning environment of cooperation and camaraderie. Several pedagogical choices support this, such as the formal technology circle and the informal way in which people are encouraged to work together.

Contribution: Learning About Us and Them

Project Inter-Actions was designed on the belief that understanding and respecting diversity is a needed step in building civic and democratic societies. It is also designed with the assumption that to un-

derstand diversity, we first need to understand and become aware of our own culture and family values.

We did not teach about culture and family values. We provided the environment and the support, and we let family members talk to each other about these subjects. Because families were required to create a final project that would represent an aspect of their cultural heritage, the conversations tended to stay focused and concrete, thus making them more engaging for young children. Children learned about cultural differences or similarities by exploring the diversity of projects and families in the workshops. Because of the complexity of the topic introduced, they also engaged in conversations with their parents that they would not have otherwise. For example, the mother of a 5 year old said,

During dinner she [our daughter] asked her dad, "What is a Muslim?" This is the first time she has taken any interest in culture and understandings of it. The notion of culture in our family is complex, and this project provided us with an opportunity to discuss culture. (Bers et al., 2004)

Conclusions: Setting a Research Program

The two different ICE presented in this article—Zora and Project Inter-Actions—have design affordances that support the development of the six Cs in an integrated way and that meet the 10 design principles that make ICE successful in their goal of fostering PYD. They are examples of technologies and technologically rich environments designed, implemented, and evaluated with the interdisciplinary theoretical framework presented earlier that utilizes ADS.

The innovative and pioneering interdisciplinary nature of this work provides methodological challenges. For example, it is hard to apply social sciences methods and tools used in disciplines such as psychology, education, and computer sciences, aimed at validating claims, to propose empirical research designs and evaluate results focusing on the discovery of new areas of knowledge. The tradition of conducting experimental studies with control groups and well-defined variables does not always provide a good rationale for answering empirical questions regarding the efficacy of particular interventions in applied, real-world, complex settings. In this respect, the design studies methodology, which attempts to "engineer innovative educational environments" (e.g., Brown, 1992, p. 141) by conducting applied research that is complex, multivariate, multilevel, iterative, utility oriented, and interventionist (Shavelson et al.,

2003), promises to provide a useful methodological framework.

At this early stage of this research program, most of the work is on defining a territory and conducting open-ended explorations and discoveries, rather than on assessing successes or failures in a replicable way. Different kinds of technologies support and enable different kinds of sustained engagement and participation. Thus, there is importance in understanding the differences in the affordances of the technologies and the approaches, as this article has attempted to do with both Zora and Project Inter-Actions, not because of their different levels of technical sophistication, but because of their different ways to engage youth in positive development.

This "basic" research needs to be done well before public systems are ready to incorporate technology in a scalable way. Research indicates that access to technology is not enough. The question is what kind of activities, opportunities for participation, and experiences can different technologies support. For example, as presented earlier, one significant future methodological challenge will be in trying to devise methods and research techniques to learn if virtual experiences that children have while engaging in ICÉ such as Zora have an impact on their everyday lives. Results from these studies might provide important information on how to create programs to promote PYD. In the long run, empirical results conducted within the research framework presented here will enable policymakers to make decisions about productive ways to invest money in technology for the purpose of fostering PYD.

The interdisciplinarity of this work has the potential to impact a new generation of both theoretical and applied students. It is my hope that students in education, psychology, and mental health related programs will explore the role of technology with respect to identity formation and PYD, and that students in computer sciences and engineering will play an active role in developing technologies of the future to support the social, moral, spiritual, and emotional development of young people.

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Received January 28, 2005

Final revision received February 17, 2006

Accepted March 16, 2006