The author presents a framework for designing and evaluating programs to support children's positive uses of technology.

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Beyond computer literacy: Supporting youth's positive development through technology

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IN THE EARLY 1900s, when John Dewey made popular such ideas as experiential, hands-on learning and education for democracy, computers were not around. Probably Dewey would have been an early adopter of social networking sites and virtual environments, as they encourage and support the formation of civic networks and public opinion. He might have been an expert with constructionist types of educational technologies, such as the Scratch programming language and its predecessor Logo, the language of the turtle, that allow children to discover powerful ideas about a disciplinary domain (for example, mathematics) by creating personally and epistemologically meaningful projects. But computers were not around in Dewey's time, and the field of educational technology spent many decades focusing on what Dewey might have considered a wrong goal: the development of computer literacy in children and youth.

There are many definitions of *computer literacy.* The U.S. Department of Education defines it as "computer skills and the ability to

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use technology to improve learning, productivity, and performance." This connotes the ability to use specific software applications for well-defined tasks, such as word processing, e-mail, spreadsheets, and Internet searches. The goal of promoting computer literacy informs most educational efforts to educate with computers. The computer literacy movement was instrumental in bringing to the attention of the American people the important role of technology in education. However, its focus was on computers as instrumental machines. This would not have sufficed for Dewey.

Seymour Papert, who led researchers and educators in understanding the potential of computers as "epistemological tools," pioneered a different approach.[1] Papert and colleagues advanced the notion that by learning how to program a computer, we learn to think about thinking in general, and about thinking in new ways within a disciplinary domain. This group introduced the notion of technological fluency to respond to the computer literacy trend of teaching instrumental skills. As information technology continuously changes over time, the technological fluency movement did not see much value in teaching people to use specific applications to complete specific task. Thus, it put forward the idea that computers are not only instrumental machines but also expressive epistemological tools that can bring new insights into our thinking by allowing us to create new ideas.[2]

Technological fluency refers to the ability to use and apply technology in a fluent way, effortlessly and smoothly, as one does with language, for many different purposes. One is fluent in French when one can read a book, write a letter, have a street conversation, and, eventually, start to think in French. Similarly, one is fluent with technology when one can find new ways of using computers in a creative and personally meaningful way—for example, to make an animated birthday card, compose a song and create an application that keeps track of what we eat, and create a neighborhood Web site. Although Dewey would have resonated with this, and indeed Papert's work has been influenced by his ideas, in this article I claim that the goal of promoting technological fluency is not enough when we think about children's needs in our digital times.

Positive technological development

Computer literacy, and its "computers as instrumental machines" approach, and technological fluency with its emphasis on "computers as epistemological tools," have the goal of promoting competence and confidence in the technological domain.[3] However, in a digital era in which technology plays a role in most aspects of a child's life, having competence and confidence to use computers might be a necessary step but not a goal in itself. Developing character traits that will serve children to use technology in a safe way to communicate and connect with others, and providing opportunities for children to make a better world through the use of their computational skills and new ways of thinking are just as important. Thus, the goal is to promote positive development though the use of technology.[4]

The Positive Technological Development framework (PTD) is a natural extension of the computer literacy and the technological fluency movements that have influenced the world of education.[5] However, it adds psychosocial, civic, and ethical components to the cognitive ones, which have a strong presence in the disciplines that study human development.[6]

PTD examines the developmental tasks of a child growing up in the digital era and provides a model for developing and evaluating technology-rich youth programs. The explicit end goal of PTD programs is not to teach children to use technology to accomplish a task, as the computer literacy movement would have claimed; and it is not solely to help them design and program their own meaningfully interactive projects, as those who seek technological fluency would have it. Rather, the goal is to mentor children in the positive uses of technology so they can have more fulfilling lives by making the world a better place.

Young people use computers to communicate with friends, listen to and exchange music, meet new people, share stories with relatives, organize civic protests, shop for clothing, engage in e-mail therapy, and find romantic partners, among many other things.[7] Although all of these activities might be facilitated by

achieving computer literacy and technological fluency, these are not enough to help youth find positive meaning in their lives—one of the goals of programs designed using a PTD approach.

From a theoretical perspective, PTD integrates ideas from the fields of computer-mediated communication, computer-supported collaborative learning, and constructionist learning with technology, with research in applied development science and positive youth development. In brief, PTD focuses on two related aspects: (1) the design and evaluation of technology-based psychoeducational programs and experiences aimed at helping young people use technology in positive ways and (2) the trajectory that leads youth to use technology to learn new things, express themselves in creative ways, communicate and take care of themselves and others, and contribute to society while developing their own sense of identity grounded on personal and moral values.

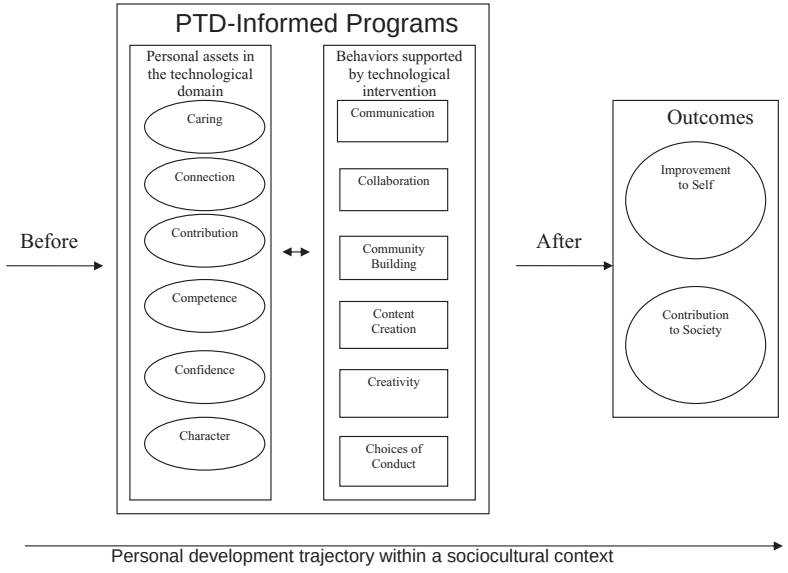
Two bodies of work have influenced the PTD framework: constructionism and Positive Youth Development (PYD). Papert's constructionism is rooted in Piaget's work and advances the idea that children learn better when exploring (computational) materials and developing their own (computational) theories. The main tenet is that computers can serve as epistemological tools when children are given the opportunity and the tools to make their own projects, thus creating their own content by learning how to program. Following Piaget, constructionism might best be defined as a constructivist philosophy for educational technologies. The claim is that by creating an external object to reflect on, people are more likely to construct internal knowledge and develop technological fluency in a playful way.[8]

Positive Youth Development research focuses on the dynamic relations between individuals and contexts by emphasizing the strengths and assets of young people instead of focusing on diminishing or preventing risk-taking behaviors. The use of the term *positive* connotes the promotion of valued characteristics and activities (developmental assets) that would lead a young person toward a good developmental trajectory (development toward the improvement of one's self and society).[9]

Informed by both constructionism and PYD, PTD is a multidimensional framework that, instead of emphasizing only developmental assets like PYD, focuses on positive behaviors supported by the technology and how those behaviors can in turn promote developmental assets (see Figure 1.1)—for example:

- A sense of competence in the technological domain is displayed by the ability to use the computer to create content using programming languages or computer applications, to debug projects, and to problem-solve. Engaging in content creation behaviors promotes the development of new concepts and skills.
- A sense of confidence in oneself as someone who can act, and learn to act, successfully in a technology-rich world, who knows how to ask for help, and who has persevered over technical difficulties is promoted when one uses technology in creative ways.

Figure 1.1. PTD-informed interventions that engage learners in using technologies to promote specific behaviors with an impact on corresponding developmental assets



- Caring, the willingness to use technology to respond to the needs of others, assumes that people can communicate through the technology. For example, social media promote new ways of communication.
- Connection, the capacity to establish and maintain positive bonds and relationships through technology, promotes and supports collaboration.
- An orientation to contribute to society by using and inventing technologies to solve social problems engages in community building.
- A sense of character, a moral compass that guides the use of technology in responsible ways, is built on having choice of conduct in the digital world. In turn, being exposed to choosing our behavior and facing consequences has an impact on the development of character.

The interventionist nature of PTD

Youth programs that are informed by the PTD framework leverage the potential of new technologies as instrumental and epistemological machines, but also as agents of change in both the interpersonal and intrapersonal domains. Interventions are focused not only on promoting developmental assets, but also on choosing technologies and pedagogical approaches that engage children in positive behaviors, such as content creation, creativity, communication, collaboration, community building, and choices of conduct.

For example, most social media tools support communication, collaboration, and community building; most constructionist types of programming environments, such as Scratch, support content creation and creativity. Other tools provide opportunities for making choices of conduct, such as virtual worlds. However, even when technology does not naturally promote positive traits, it can be manipulated to do so by integrating it with other learning activities. For example, on my research projects with robotics and young children, we make a conscious choice to engage children in

making moral choices. Instead of giving each child a robotic kit with already sorted pieces, we ask them to choose their pieces from communal bins. Thus, they learn how to negotiate and how to make choices (Should I take them all? Should I take only what I need? Should I ask people if it is okay if I take all light sensors since probably no one else will use them?).[10]

PTD informs the design of interventions purposefully conceived for promoting positive outcomes in young people through technology. Thus, the PTD framework guides the curriculum development, the setup of the learning environment, and the choice of technologies used. In the following section, I present a case of research-based youth programs that we have conducted over the years in my Developmental Technologies research group at Tufts University, using the Zora virtual world.

Building virtual cities

Zora is a three-dimensional virtual world that provides easy-to-use tools for children to design and create a graphical virtual city.[11] It was designed as part of my doctoral work at the MIT Media Lab and then updated by my Developmental Technologies research team at Tufts University. Users can populate the world with houses and objects, as well as interactive characters, stories, values, and their definitions. They can navigate and inhabit the city through an avatar and communicate by chat and asynchronously. Zora provides opportunities to create password-protected, safe, monitored spaces for young people. Multiple cities can be created as multiple youth programs and studies are conducted. Everything that children say or do in Zora is recorded in a time-stamped log, which enables later data analysis.

Using the PTD terminology, Zora's design provides tools for engaging in:

- *Content creation* by designing a virtual city with personal homes and public spaces, interactive storytellers, and objects. The Zora

authoring tools foster competence in the development of computer literacy and technological fluency.

- *Creativity* by using different media to express ideas in virtual spaces and solving technical problems. By using the Zora tools in creative ways, children develop a sense of confidence in their learning potential.
- *Collaboration* tools to promote caring about others by engaging in shared projects and providing support and guidance to each other in the learning community.
- *Communication* mechanisms through both synchronous and asynchronous exchanges that promote a sense of connection among peers or with adults.
- *Community-building* virtual spaces and tools that enable the formation of a social support network that can bridge, in some cases, to face-to-face exchanges. This promotes contribution to make a better learning environment, community, and society.
- *Choice of conduct* by engaging youth in the creation of a collaborative values dictionary that guides actions in the virtual world and the design of narrative-based models of identification, such as heroes and villains, that provoke examination of values. Combined, these Zora features enable users to explore *character traits* and their ethical and moral dimensions while assuming a responsible use of technology in the virtual city.

Several youth programs were run over the years with Zora as applied pilot research projects to evaluate PTD outcomes:

- Dialysis patients and posttransplant pediatric patients at Children's Hospital Boston and Tufts Medical Center created a virtual city to explore issues of medical adherence and school transition.[12] At the same time, it created a peer support network.[13]
- Youth affected by cancer and blood disorders created a virtual summer camp to maintain camp friendships built at Camp for All in Burton, Texas and to improve and sustain their sense of hopefulness and social connectedness.

- Incoming college freshmen at Tufts University created a campus of the future to explore civic connections between campus and community.[14]
- A national and international network of youth participating in an after-school computer-based learning network, the Intel Computer Clubhouse, used Zora in both English and Spanish to learn about each other.[15]

All of these research programs were developed following the PTD framework, and studies were and are being conducted to evaluate how participating youth, in their similarities and differences, their needs and expectations, use the technology in positive ways.[16] It goes beyond the scope of this article to present results from those studies, since the goal is to introduce the PTD framework. But those can be found in several publications that are linked from the Developmental Technologies Web site: http://ase.tufts.edu/DevTech/.

Hopes and potential

Digital technologies are changing the developmental landscape for young people. The task of designing innovative approaches to support children and youth in their good uses of technology goes beyond educators. It involves families, child development experts, mental health professionals, child advocates, and all others who have influence in a child's life. However, the frameworks that guide our actions are important, as they will guide the types of programs and technologies that are implemented, as well as the kinds of learning cultures and social climate that will emerge in our interventions. I suggest that computer literacy and technological fluency, the traditional goals of those working with educational technologies, are not enough. We need to craft digital experiences to help children develop a sense of identity grounded on personal and moral values and engage them in using technology to make the world a better place.

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