From Bits and Bytes to C++ and Web Sites: What Is Computer Talent Made of?

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IN TODAY'S SOCIETY, one doesn't have to look far to find examples of extraordinary computer technology ability. Steve Jobs started Apple at age 21; Bill Gates was only 20 when he created Microsoft. As the world of computer technology continues to change and to grow, it is becoming more obvious that some students demonstrate an exceptional ability for learning and understanding the workings of computers.

The focus of this pilot study was to explore possible patterns of formative experiences, cognitive abilities, and personality characteristics that could be labeled as "computer technology talent." Nine members of a high school computer programming club participated in a technology-based project with the researchers. As part of the project evaluation, each student took part in a semi-structured interview with one of the researchers. Questions encompassed perceptions and evaluations of the project, as well as explorations of dimensions of computer technology talent. Findings included discernable patterns and recurring themes in these students' lives, which were reflected in their histories with computing, family support, and key educational experiences.

Background

Since personal computers started gaining popularity in the early 1980s, researchers and practitioners have been interested in how this form of technology could be harnessed to better serve the education of children and youth. For example, an early article investigating this topic (Steele, Battista, & Krockover, 1982) focused on the benefits of computer-instructed mathematics programs on the computer literacy of gifted students.

Further analyses of the literature concerning computer technology and talent yielded seven conceptual themes: (1) classroom applications; (2) parental involvement; (3) the sociology of computing; (4) gender differences; (5) technology as a way of thinking and knowing; (6) developmental aspects of this area; and (7) computer technology talent.

Classroom Applications

The largest category of professional literature on computer technology is filled with descriptions of ways that teachers might provide technology-driven learning opportunities in the classroom for intellectually gifted students (Belcastro, 2002; Pyryt, Masharov, & Feng, 1993; Riley & Brown, 1997). Articles of this sort tend to emphasize the educational importance of using computers with gifted students or describe programs that centered on technology use (Morgan, 1993; Nugent, 2001). For example, Jones (1990) described three levels of computer use and suggested that gifted students need to move beyond the first level of "computer as tutor" and the second level of "computer as research/exploration guide" into the highest level of using a computer as a tool for asking "bigger and better questions." It is clear that using advanced technology can aid intellectually gifted and talented students, but these articles do not directly address the idea that there could be a subset of students who exhibit a specific technology talent. In these articles, technology use tends to be applied to another subject area like science or communications and is not considered as its own talent area.

Parental Involvement

This category features articles on the key role parents or other adults can play in encouraging a child's computer use for more than simple gaming or

Internet surfing (Attewell, & Battle, 1999). In the early 1990s, one study (Giacquinta, Bauer, & Levin, 1993) found that the majority of parents offered no computer assistance to their children, either because of "unwillingness or lack of skill." A more recent article (Attewell, Suazo-Garcia, & Battle, 2003) supported this finding with the observation that children with computers are almost never accompanied by an adult when working or playing with a computer. Those parents who do show an active interest in their child's computing demonstrate six kinds of involvement: provisioning, goal setting, praising, modeling, coaching, and scaffolding (Giacquinta, Bauer, & Levin). This finding echoes a theme uncovered by Bloom and associates in their study of world-class talent: that a child's talent area is like a language spoken in the home, valued and modeled through parental involvement (Bloom, 1985). Some children have become authorities in the area of technology before their parents because, unlike previous revolutions, the digital revolution is not completely in the hands of adults (Tapscott, 1999). As society continues to move forward, the duty of parents to ensure their child has "technology literacy" becomes more critical, especially if the child has demonstrated talent in that area (Siegle, 2004).

Sociology of Computing

Another topic of interest related to technology is how the world of computers has affected the social interactions of children, youth, and adults. This concern is typified by an article published in *American Psychologist* that examined the concept of "Internet paradox" (Kraut et al., 1998). The authors asserted that person-to-person communication was the dominant purpose of Internet usage, but an increase in online time appeared to be associated with a decrease in social involvement and psychological well-being among new Internet users. But, when the variable of extroverted vs. introverted personality was measured in a subsequent study, personality was revealed as a better variable in predicting an individual's community involvement and loneliness than his or her hours of computer use (Kraut et al., 2002). In the area of interpersonal relations, a study by Mendaglio (1995) suggested that gifted students were likely to demonstrate more interpersonal sensitivity and empathy than other children, but there have been no systematic investigations on the effect of Internet social groups on the emotional state of intellectually gifted students. Research on the long-term societal impact of this new global community is still in its early stages, but it holds promise for future studies.

Gender Differences

The gender gap in computer use has been addressed to a limited degree in the educational literature (Green, 2000; Macleod, Haywood, Haywood, & Anderson, 2002; Nugent, 2001). The general consensus appears to be that girls and women have dramatically increased their computer usage during the last decade, but there is still a large discrepancy between the proportions of males and females who entered the computing field. In fact, the number of women computer professionals in the U.S. workforce dropped during the 1990s from 35.4% to 29.1% (McLester, 1998). There are a few strong female voices in the computer world who advocate teachers involving girls in computing activities in elementary school, which appears to help girls incorporate technology skills into their sense of self (Ettenheim, Furger, Siegman, & McLester, 2000). What research there is on gifted girls and technology suggests that, if they are discouraged from using computers at an early age, then they are at risk of missing out on developing advanced problem-solving skills promoted by computer use (Berger, 2003).

Technological Thinking

The articles we assigned to this category tend to focus on student learning styles that are compatible with computer use (Bulls & Riley, 1997; Cohen, 2001). Bulls and Riley suggested that computers can accommodate students who prefer self-directed individual work, as well as students who prefer using it as a tool for collaborative project-based learning. There has been some interest in defining different ways that computers impact human cognition. For example, one study (Salomon, Perkins, & Globerson, 1991) hypothesized that there are two key cognitive effects of technology on an individual: increased performance while using technology and positive residual effects after using technology. Salomon et al. concluded that computers do make a noticeable difference in human thinking, but that people need to view a computer as a "cognitive partner," instead of as a substitute for the human brain. Another group of researchers (Bowen, Shore, & Cartwright, 1992) explored an interesting question: Do intellectually gifted children use computers differently from other children? Using a software package called *The Factory*, investigators observed children ages 10 and 11 and compared the behaviors of students from an enriched gifted class to students from a general education class. The intellectually gifted students using this computer program planned their steps better beforehand, and they also had less trial and error before creating their final product. All of the students accomplished the same activity goal, but the study documented that intellectually gifted students used the software quicker and more efficiently.

Development of Technology Talent

In this category, writers emphasize the importance of technology to the future of gifted education programs (Little, 2001). Researchers have postulated that the intellectual leaders of tomorrow need to be prepared to deal with high-tech problem solving. One study by Sewell (1990) suggested that computers are an essential part of an enriched educational environment where students learn more effectively than in traditional settings. Based on this conclusion, he proposed that development can be accelerated and higher goals expected at an earlier age. Other writers have warned that, if young children rely too heavily on computers for their acquisition of knowledge, they could possibly miss out on other important social and sensory modes of learning (Armstrong & Casement, 2000). There is also a mild controversy about whether computers are even appropriate for use at all during certain developmental levels (Stoll, 1999). There is still much to be learned about how growing up with computers has affected the learning of gifted children over the past few decades.

Computer Technology Talent

We found a small number of limited technology talent identification scales (e.g., Gagné, 1999; Renzulli et al., 2004), and there was a paucity of research-based studies on this kind of talent. Our search revealed one comprehensive plan that included identification scales and a comprehensive curriculum. The United Kingdom's national curriculum Web site featured two types of computer technology talent: "Design and Technology" (http://www.nc.uk.net/gt/design) and "ICT" (http://www.nc.uk.net/ gt/ict). This two-part categorization was supported by MIT psychologist Sherry Turkle (1997), who interviewed early adopters of home computers and found two distinct groups of adults whom she labeled "hackers" and "hobbyists." A hacker is someone "interested in taking large, complex computer systems and pushing them to their limits," whereas a hobbyist is someone whose "goal is to reduce a machine to its simplest elements in order to understand it as fully as possible." These different descriptions led us to hypothesize that the definition of computer technology talent is more complex than one simple category.

Literature Summary

Overall, the majority of the research in this area has been qualitative and anecdotal. Studies that were quantitative focused on computer use, rather than technology talent. There were some intriguing possibilities for defining, identifying, and serving students with computer technology talent; however, this seems to be a road less traveled.

Methods and Procedures

Setting

The study was conducted in a medium-sized Midwestern college town (population of approximately 80,000 full-time residents). Slightly more than 10,000 students are enrolled in the public school system (Friedman-Nimz, Lacey, & Denson, 2002). The local school district features 2 high schools, 4 junior highs, and 18 elementary schools.

Currently, all elementary buildings contain a computer lab. At the elementary level, the students use drill-and-practice programs for subjects like math and learn to type on the computer and print a final copy. At the upper elementary grades, keyboarding skills and word processing is the focus. In seventh grade, all students are required to complete a keyboarding class or test out of it. To aid teachers and find an outlet for technically talented students in the junior high schools, for several years, groups of students at each school have assisted classroom teachers who are "technologically challenged." These students place assignments online, create materials for use in the classroom, create graphs and charts, and keep records for some of the teachers. At the senior high level, students may enroll in a computer applications course, a computer programming course, and/or a course in computer graphics. However, for students who are eager to know more about technology, a sentiment has been expressed by gifted education and general education teachers, students, and parents that the provisions provided are inadequate for students with high intellectual or computer technology potential (Friedman-Nimz, Lacey, & Denson, 2002).

The LearnGen Project

The School of Education at the local university was the recipient of a U.S. Department of Education PT3 grant (Preparing Tomorrow's Teachers to use Technology). A key purpose of the LearnGen project was to construct work groups (called "cohorts") consisting of field-based and preservice teachers and K–12 students to learn new technology applications and new content in a pertinent discipline. A cohort was developed to explore new ways to provide more authentic opportunities for high school students whose technology expertise challenged the district's ability to provide fitting learning opportunities. The cohort in this study focused on developing a Web site to supplement instruction in an entry-level graduate course in gifted education, which is required for all graduate students seeking a gifted endorsement. The professor was treated as the "client," and the students functioned as if they were a workgroup in a Web design business creating a product for a customer.

Sample

The teacher members of the cohort consisted of one university professor who coordinated the gifted education endorsement and degree programs, two field-based gifted education facilitators, and two preservice teachers completing minors in gifted education. Student participants were nine adolescent high school students (eight males and one female) who were members of the school's extracurricular computer programming club. According to the club's advisor (one of the field-based teachers), these students demonstrated extraordinary computer technology proficiency. Six of the nine students were also formally identified as gifted according to local and state policies; however, this was not a label that determined a student's inclusion in the project. The group consisted of one Asian American and eight Caucasian students, with individual socioeconomic status unknown. However, the attendance area for the school features a broad range of SES and ethnicity; thus, one might expect a similar distribution among project participants.

Design

A broad, exploratory approach was employed to construct the semistructured interview schedule. Our desire was to elicit rich personal narratives that could be examined for patterns, themes, and turning points that could be common across individuals. Thus, we included questions about history with computing, important turning points in and out of school, and technology at home (see Figure 1). Gardner's (1983) theory of multiple intelligences was also incorporated into the interview, with students rating their intelligence strengths on a scale of 1 to 7 for each intelligence. All five teacher members of the cohort collaborated on constructing the interview protocol. Students who agreed to participate were interviewed individually and privately, using a semistructured interview. All interviews were audiotaped and transcribed, and all identifying information was removed. Parents/guardians were contacted for permission to interview, and the students completed a consent form, as well.

Findings and Discussion

All student participants indicated that working on the project was a satisfying and educational experience relative to learning and using computing skills. Their feelings of ownership of the project was reflected by one student who commented, "It seemed like *my* project." In their interviews, students highlighted that they enjoyed the opportunity to learn and to apply new skills to build a product that would be used in a real-world setting, not simply as a class exercise. As the students evaluated and reflected on the experience, several of them expressed the desire to learn organizational and management skills, particularly how to facilitate communication among several work groups. One student summed up the benefits as follows: "From my experience in this project, I can, in the future, organize and distribute the work among more people." Students also commented that they learned how to interview prospective clients so that the work could be accomplished efficiently.

A content analysis of students' histories was compared to key categories in the professional literature. We hoped to find confirmation in the literature for important themes in our sample's histories. For example, support for computer technology as an instructional tool was reflected unanimously in students' early experiences. All the students indicated that they experienced computer technology as an instructional tool, especially from 7th through 12th grades. For example, one student described using the computer program Flash to develop games for one of his teachers to use for content review with her classes. They all mentioned parental support as being strong, from finding tutors if the parents lacked the expertise the student needed, to making it financially possible for students to attend university classes and workshops. "My dad likes to tinker with all kinds of technology," observed one student. There was only one female student in this study, reflecting that computer programming still appears to be a male-dominated area of interest. Interestingly, she was one of the more entrepreneurial members of the group; she had operated a consulting service since sixth grade and had a core of regular clients.

Literature on the topic of the sociology of computing suggests that computers have a profound effect on social involvement, which was confirmed by our sample. About two thirds of the group preferred to interact with others around a computer screen. For example, as a means of socializing, the club held regular LAN (Local Area Network) parties, in which students would network their computers together to play complicated games. These were also students who preferred to work independently in general. Relative to a developmental path, the majority of students started working with computers between sixth and seventh grades. This time period appears to coincide with the explosion of the World Wide Web in the mid-1990s. Only two students indicated working with computers in third or fourth grade. This finding might also be attributable to the state of the field 10 years ago—when home computers were not as prevalent as they are now.

Although the literature we reviewed included questions, suggestions, and concerns relative to the effects of computer usage on cognitive and social development, we did not find research regarding an expected developmental trajectory of computer technology talent. We did find commonalities in our sample's histories. For instance, the developmental path the students described began with using the computer as an education tool or as a toy in middle childhood. Then they moved on to creating simple Web pages, accelerated into building their own computers, and learned programming languages such as C++. Some students even obtained technical certifications such as A+ and became known for their technology skills in a variety of settings. "I became the family tech," commented one student.

Technology Experiences/Interests

1. How did the work on LearnGen build on your previous experiences?
2. Please tell me a little about your history with computing: when you started, encouragement at home, your classmates' part if any, school's part, out of school assistance.
3. Did you take any helpful courses, workshops, or other experiences? Please describe. Were they in/out of school?
4. Please describe your technology-related high school experiences, such as video, graphic art, engineering, computer science, tutoring/consulting with teacher and/or students. Any projects in or out of class?
5. What would have made your school experiences closer to ideal (elementary, junior high, senior high)?
6. What are your technology strengths? Programming, graphics, problem solving, Web page design?
7. How does technology relate to your interests in and out of school now? Community service? Job?
8. What technology do you have now? What would you have in an ideal world?

Technology Thinking

9. Below is a list of the ways in which people think. Please rate how each type of thinking is like you (7 = very much like you; 1 = not at all like you).

   _____ Numbers
   _____ Words
   _____ Pictures
   _____ Music
   _____ Spatially
   _____ Relationships among people
   _____ Movement

10. Do you play chess? If so, for how long? Have you played competitively? Earned any titles?
11. Do you play computer games? What kinds? What do you look for in a game?
12. Do you prefer to work independently or in groups?

Figure 1
Interview questions

The interview data were analyzed for patterns in the student responses that related to their current computer-related interests and achievements. Interestingly, two distinct categories of students emerged: one group whose members specialized in programming and a second group whose self-identified strengths were problem solving and high-level applications of software. We labeled these two groups as "programmers" and "interfacers," respectively.

Programmers

Programmers were students who enjoyed working alone with computer language and spending hours deciphering code and playing with creative programs. Many had worked on the school's Web site or on their own sites since middle school. They completed the available computer classes offered by the school district, but often felt frustrated by the slower pace. One student reported, "I took a computer programming class at [high school], but the curriculum for both Computer Programming I and II could have been finished in about a quarter." Some of the students chose to take classes at the local university in the summer, and they expressed the belief that the challenge of college courses was better suited to their skill level than school-based offerings. When asked to suggest improvements that could be made at all school levels, the programmers mentioned more advanced classes, more individualized instruction, and more computers available for student use.

The distinguishing characteristics of the programming group began to emerge in their responses to self-perceived strengths and their self-evaluations of intelligence. Figure 2 shows that nearly the entire group mentioned logic, problem solving, and programming as part of their technological strengths. These students enjoy creating new programs and dealing with the infinite possibilities of computer language. They also rated themselves high on spatial thinking and medium on relationships with other people. These students socialized well with their peers in the computer club, but when it came to content learning in the classroom, they preferred to work independently.

What are your technology strengths? Programming, graphics, problem solving, Web page design?

Programmers

Student 1	I've got a pretty good mind for logic, so I can see how to use programming to solve a problem; I can sift through information to solve.
Student 2	Web development, problem solving, and simple graphics.
Student 3	Programming and problem solving are my strengths.
Student 4	Not really focused—would like to focus on programming. With programming there is a lot to do.
Student 5	Programming, problem solving, working with operating systems.
Student 6	Animation video—I'm able to learn the tools faster.

Interfacers

Student 7	Troubleshooting, diagnosing.
Student 8	Graphics and layout. I guess I'm more of an artsy person.
Student 9	Problem solving, troubleshooting—that kind of thing.

Figure 2
Participant responses to interview question #6

Interfacers

The students we designated as interfacers indicated that they enjoyed helping their teachers and peers at school with their computer technology problems. They were less interested in exploring the computer itself (i.e., hardware) and more into the social interactions that resulted from helping people with technology. One student said, "I lend my services to others . . . like troubleshooting, about 1 or 2 hours a week on average." Their skill level was not noticeably different from the programmers, but they expressed that they would become bored with nothing but coding all day. The excitement of unraveling and solving technical issues and improving old technology appeared to be intrinsically motivating. All three had served as assistants to teachers or been aides in the high school's computer lab. These students extended their skills further into the community by helping neighbors, churches, and family members. The improvements the interfacers suggested for their school focused on learning information at an earlier age and having more knowledgeable teachers who shared their interests.

On the multiple intelligences scale, they rated themselves high on spatial thinking, as well, but also high on music and relationships with people. As shown in Figure 2, they mentioned words such as *diagnosing*, *problem solving*, and *troubleshooting* to describe their technology strengths. They talked about their skills in relation to getting things done, like one student who quipped, "I'm always the fixer." The importance lies in being able to understand the computer from every possible angle and fix problems that occur within the existing frameworks. Because these students also mentioned valuing human interaction so highly, they enjoyed working on projects in groups more than the programmers, and they valued the creative thinking that came from group work.

Conclusion and Implications

The primary purpose of this study was to explore an area of talent specific to computers and technology in the larger domain of giftedness. Results of this pilot project suggest that there are two subtypes of computer technology talent among adolescents: programming and interfacing. This finding is important because three of the nine participants had not been identified as gifted, and yet there was no difference in the quality of their work compared to the other students who had been identified. If computer technology is ignored as a domain of talent, one might hypothesize that a noticeable group of high-potential students are not receiving needed services to develop their potential.

One might question if computer technology talent is a distinct type of talent, or if it is merely a hybrid of verbal and mathematical abilities (reflected in learning computer languages and in solving complex problems), combined with high interpersonal sensitivity. We posit that computer technology talent fits Feldman and Goldsmith's (1986) coincidence theory of talent emergence. They explain that the term *coincidence* represents "the melding of the many sets of forces that interact in the development and expression of human potential." They identify four time frames whose juxtaposition creates a situation ripe for a prodigious talent to emerge in a particular domain. From narrowest to broadest, they are: the person's life span; the development of a field or domain; the qualities of the cultural and historical context; and evolutionary forces. Thus, we suggest a coincidence lifespan development, reflected in high levels of cognitive development (i.e., abstract thinking qualities) and affective development (i.e., interpersonal perspective taking, intrinsic motivation). Development of a field or domain is reflected in the emergence of personal computers and the launching of the Internet. Home/school accessibility and high social value of computer technology reflect a unique cultural and historical context. Evolutionary time might be described in terms of the global village of the human species, making time and space simultaneously shrink and become more complex. Coincidence theory opens a conceptual door to the possibility of considering computer technology as a talent domain.

This study was limited to a small number of high school students who volunteered for a computer programming club-university joint project. Before any generalizations can be made, other age levels and school settings need to be explored to validate, expand, and refine profiles of high-technology-ability students. We have used the findings of this pilot exploration to develop thumbnail sketches of high-ability programmers and interfacers (see Figure 3). We plan to use these sketches to help teachers identify students with extraordinary computer technology potential for further assessment and possible services.

When considering suggestions for teaching, it is important to focus first on the interests and self-identified abilities of the students to shape program options, rather than just on local resources such as teacher expertise and hardware/software availability. Educators need to listen to the experiences of their students, as in the case of one student who said, "I learn best by spending a ton of time on the computer exploring. The typing teachers almost discourage it; they're afraid you're going to break it." By releasing some control to the students and playing the role of a facilitator, teachers can help them along their path of computer exploration. Teachers need to pay closer attention to those students who stay after school in the computer lab to tinker for hours and treat them as if the next Bill Gates or Steve Jobs could be sitting there. If in Great Britain computer technology is recognized as a distinct talent, perhaps this could be a justification for similar identification and programming in the United States.

A good place to start the process of developing alternatives for students who appear to demonstrate computer technology talent potential are the International Society for Technology in Education's National Educational Technology Standards for students (http://cnets.iste.org/students). Use off-grade-level standards to select goals and generate related activities. Encourage students to self-teach computer languages and software, and provide support to help students work past frustrations and trace their thinking strategies.

E-mentors can model appropriate experiences with online, informal learning, such as user groups for particular software packages. Students can learn online communication etiquette through keeping an educa-

Programmers

Sam is a student who enjoys working alone with the computer language and spending hours deciphering code and playing with creative programs. He has worked on the school's Web site since middle school, as well as creating a personal site about his favorite movies and music. A junior in high school, he has completed all of the available computer classes offered by the school district. Because he often felt frustrated by the slower pace, Sam took several classes at the local university in the summer. In his opinion, the challenge and pace of college courses were better suited to his skill level and learning style. When he was asked to suggest improvements for his high school's computer technology courses, he recommended offering more advanced classes, more individualized instruction, and more computers available for student use. He identified his technological strengths as logical thinking, problem solving, and programming skills. He socializes well with his peers in the computer club, but generally prefers to learn independently.

Interfacers

Since about fourth grade, Jean has been a computer troubleshooter. She especially enjoys helping her teachers and classmates solve their computer technology software problems. She is less interested in exploring the computer itself (e.g., hardware) and is more interested in the social interactions resulting from helping people with technology. She expressed that she would become bored if she were to write programming codes all day, and instead prefers to vary her computer interactions. The excitement of unraveling and solving technical issues and improving old technology appears to be intrinsically motivating to her. She had served as an assistant to teachers in middle school and is currently an aide in the high school's computer lab. Jean also extends her skills further into the community by helping neighbors, churches, and family members with their computer questions. When she was asked to suggest improvements for her high school, she recommended offering students the chance to learn about software in elementary school, and connecting students with knowledgeable teachers who shared the same computer interests. She mentioned diagnosing, problem solving, and troubleshooting as her technology strengths. She enjoys working on projects in groups, and thrives on the creative thinking that comes from group work.

Figure 3
Thumbnail sketches

tional blog on a designated topic or joining a public chat or threaded discussion related to current events or a local issue. Substantial learning in the adult technology world emerges in group settings; teachers might also team students across schools or districts to work together on a project or problem. Team students in similar skill/knowledge groups when working on technology-assisted projects, rather than assigning the most advanced learner as a group leader.

There are some specific objectives that we are interested in for broader and deeper understandings of computer technology talent. We need to (1) gather more information to provide a more detailed picture of the intellectual and personal qualities of adolescents demonstrating computer technology talent; (2) evaluate the ways in which this constellation of qualities appears to constitute a unique talent; and (3) develop protocols for exploring this phenomenon developmentally (i.e., among children and younger adolescents). We predict that technology will continue to be a focus in gifted education, and future studies can impact this area greatly. GCT

References

Armstrong, A., & Casement, C. (2000). *The child and the machine: How computers put our children's education at risk*. Beltsville, MD: Robins Lane Press.

Attewell, P., Suazo-Garcia, B., & Battle, J. (2003). Computers and young children: Social benefit or social problem? *Social Forces, 82*(1), 277–296.

Attewell, P., & Battle J. (1999). Home computers and school performance. *The Information Society, 15*(1), 1–10.

Belcastro, F. (2002). Electronic technology and its use with rural gifted students. *Roeper Review, 25,* 14–16.

Berger, S. (2003). Surfing the net: Are we dumbing down our daughters? *Understanding Our Gifted, 15,* 24–27.

Bloom. B. S. (Ed.). (1985). *Developing talent in young people.* New York: Simon & Schuster.

Bowen, S., Shore, B. M., & Cartwright, G. F. (1992). Do gifted children use computers differently? A view from "the factory." *Gifted Education International, 8*(3), 151–154.

Bulls, M. R., & Riley, T. L. (1997). Weaving qualitatively differentiated units with the World Wide Web. *Gifted Child Today, 20*(1), 20–27.

Cohen, V. L. (2001). Learning styles and technology in a ninth-grade high school population. *Journal of Research on Technology in Education, 33,* 355–366.

Ettenheim, S. G., Furger, R., Siegman, L., & McLester, S. (2000). Tips for getting girls involved. *Technology & Learning, 20*(8), 34–36.

Feldman, D. H., & Goldsmith, L. T. (1986). *Nature's gambit: Child prodigies and the development of human potential*. New York: BasicBooks.

Friedman-Nimz, R., Lacey, J., & Denson, D. (2002, December). Teaming with G/T students: Improving online teacher education. *The KGTC Bugle*, 4–5.

Gagné, F. (1999). *Tracking talents: Identifying multiple talents through peer, teacher, and self-nomination*. Waco, TX: Prufrock Press.

Gardner, H. (1983). *Frames of mind: The theory of multiple intelligences*. New York: BasicBooks.

Giacquinta, J. B., Bauer, J. A., & Levin, J. E. (1993). *Beyond technology's promise: An examination of children's educational computing at home*. Cambridge, MA: Cambridge University Press.

Green, M. (2000). Why aren't girls more tech savvy? *NEA Today, 19*(3), 31.

Jones, G. (1990). *Personal computers help gifted students work smart* (ERIC Digest #E483). Retrieved May 16, 2005, from http://www.hoagiesgifted.com/eric/Archived/e483.html

Kraut, R. E., Patterson, M., Lundmark, V., Kiesler, S., Mukhopadhyay, T., & Scherlis, W. (1998). Internet paradox: A social technology that reduces social involvement and psychological well-being? *American Psychologist, 53,* 1017–1032.

Kraut, R., Kiesler, S., Boneva, B., Cummings J., Helgson, & Crawford, A. (2002). Internet paradox revisited. *Journal of Social Issues, 58,* 49–74.

Little, C. (2001). Probabilities and possibilities: The future of gifted education. *Journal of Secondary Gifted Education, 12,* 166–169.

Macleod, H., Haywood, D., Haywood, J., & Anderson, C. (2002). Gender and information and communications technology: A 10-year study of new undergraduates. *TechTrends, 46*(6), 11–15.

McLester, S. (1998). Girls and technology: What's the story? *Technology and Learning, 19*(3), 18–26.

Mendaglio, S. (1995). Sensitivity among gifted persons: A multi-faceted perspective. *Roeper Review, 17,* 169–172.

Morgan, T. D. (1993). Technology: An essential tool for gifted and talented education. *Journal for the Education of the Gifted, 16*, 358–371.

Nugent, S. R. (2001). Technology and the gifted: Focus, facets, and the future. *Gifted Child Today, 24*(4), 38–45.

Pyryt, M. C., Masharov, Y. P., & Feng, C. (1993). Programs and strategies for nurturing talents/gifts in science and technology. In K. A. Heller, F. J. Mönks, & A. H. Passow (Eds.), *International handbook of research and development of giftedness and talent* (pp. 453–471). Oxford, England: Pergamon.

Renzulli, J., Smith, L. H., White, A. J., Callahan, C. M., Hartman, R. K., & Westberg, K. L. (2004). *Scale for rating the behavioral characteristics of superior students*. Mansfield Center, CT: Creative Learning Press.

Riley, T. L., & Brown, M. E. (1997). Computing for clever kids: The future is what we make it. *Gifted Child Today, 20*(5), 22–29.

Salomon, G., Perkins, D., & Globerson, T. (1991). Partners in cognition: Extending human intelligence with intelligent technologies. *Educational Researcher, 20*(3), 2–9.

Sewell, D. (1990). *New tools for new minds: A cognitive perspective on the use of computers with young children*. New York: St. Martin's Press.

Siegle, D. (2004). The merging of literacy and technology in the 21st century: A bonus for gifted education. *Gifted Child Today, 27*(2), 32–35.

Steele, K., Battista, M., & Krockover, G. (1982). The effect of microcomputer assisted instruction upon the computer literacy of high ability students. *Gifted Child Quarterly, 26*, 162–164.

Stoll, C. (1999). *High tech heretic: Why computers don't belong in the classroom and other reflections by a computer contrarian.* New York: Doubleday.

Tapscott, D. (1999). *Growing up digital: The rise of the net generation*. New York: McGraw-Hill.

Turkle, S. (1997). *Life on the screen: Identity in the age of the Internet*. New York: Touchstone.

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