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Abstract:

The decline in new entrants to IT professions coincides with the burgeoning use of new information and communications technologies among adolescent users. Teenage girls embrace a wide range of new technologies, yet are less interested in IT-related careers or college majors than their counterparts in earlier years. In order to forestall further declines in IT college majors, educators in middle schools and high schools must learn how to better instill an appreciation for IT career opportunities in their students. The purpose of this paper is to report on our descriptive study of teenagers' technology-based perceptions, habits and interests, and to explore the link between these usage patterns and other personal attributes concerning technology access in their homes and schools. Analysis of more than 300 surveys reveals both similarities and differences in male and female elective technology use. Of particular note is that many of the gender-related differences do not appear until high school. This signals that students must be made aware of the importance and benefits of computing technology for purposes other than leisure or social interaction in the lower grades, and also in the home. We also find significant differences in gender-based usage patterns and perspectives on computing. With this understanding of current usage patterns, educators and employers will be in a better position to review IT-related pedagogy and curricula, and to appraise IT career options in a more informed light.

Keywords: teenagers and technology; gender; patterns of use; technology in the home; middle school technology use; high school technology use

Editor's note: An earlier version of this paper was presented at AMCIS (Vilvovsky et al., 2008).

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I. INTRODUCTION

Universities around the world are facing declining enrollments in information technology-related majors, including information systems.[1] In many cases, there is evidence that the decline in student interest in IT-related careers is steeper for female students.[2] The percentage of computer science degrees awarded to women has declined dramatically in recent years, from 37 percent in 1985 to 22 percent in 2005, and only 0.4 percent of women freshman indicated they intended to major in computer science in 2006 [Klawe, Whitney, and Simard, 2009]. This raises new concerns among employers, as these trends also play out among the ranks of information systems professionals. Companies are worried that women are choosing not to enter computer professions, and, in fact, are leaving at a fast pace. This concern is concisely expressed by the title of a recent CIO Magazine article, "Where Have All the Women Gone?" referring to the decline in women entering, staying in, or retraining for an IT career.

> "The balance is shifting, but for companies like Siemens the industry has not in the past lent itself to promoting women…. Local schools are very important here. The key is to switch on interest early at school. By the time children are 14 they are choosing options…."
>
> Sue Bagguley, CIO, corporate business technology, business operations, Siemens [in Burgess, 2008]

The declining female college enrollment in IT majors reflects a need for more intensive and focused action aimed at younger students [NSF, 2006; Cohoon and Aspray, 2008]. As early as middle and high school, computer curricula seem to be biased toward male preferences and learning patterns. There is a need to align technology curricula and diversify material presentation to address the learning preferences of both males and females in their formative teenage years.

> "… (T)he lack of interest in IT stems from an early age. There are a range of reasons for the dearth of women in the [IT] profession, but the games market is one of the possible reasons. Most games have been designed for boys…."
>
> Mary Hensher, CIO, Deloitte [in Burgess, 2008]

The popular press often asserts that teenagers' patterns of technology use are affected by gender. One encounters frequent news accounts about how boys spend an excessive amount of time playing video games, often violent ones. Yet there is only scattered evidence about how gender shapes youths' preferences for other technology-mediated activities as teenagers pass through their formative years.

> "Promoting IT is about getting the right hooks."
>
> Mary Henscher, CIO, Deloitte [in Burgess, 2008]

In order to better understand the educational environment in which both boys and girls can learn to appreciate computers and perhaps elect computing careers, we need to consider the technology-based preferences, habits, and interests they bring into the classroom. The purpose of this paper is to report on our study of teenagers' perceptions, habits, and interests, and to relate teenage computer use to the range of activities they partake in during the school year. Armed with a better picture of current student habits and interests, educators and employers will be in a better position to guide and influence teenagers' selection of college major and career path through the creation of interesting pedagogy and curricula and restructured work environments.

The remainder of the paper is organized as follows. The next section contains an abbreviated literature review. The data collection method is described next, followed by analysis of the results concerning technology ownership, everyday activities—both computer-related and not computer-related, computer usage, and technology education.

[1] There is some good news reported about programs experiencing some enrollment increases, but the numbers are still far below recent historical highs [Thibodeau, 2010].

[2] In one striking example, Panko (2008) noted that women once made up almost 40 percent of his student base, their numbers peaking at 50 percent in 2000–2001, and falling to 15 percent in 2005–2006, 10 percent in 2006–2007, and 9 percent in 2007–2008. The percentage of girls in Australian ICT programs has hovered around 25 percent for decades (Rowan and Bigum, 2010).

The paper concludes with a discussion of future research and possible implications of the findings for gender and IT researchers, and for parents, schools, and policy makers who are in a position to provide positive direction to teenagers about how to most effectively benefit from the wealth of technology to which they are exposed.

II. BACKGROUND

Researchers have published many studies acknowledging gender-based differences in technology use in companies and across cultures. Most U.S. based research shows that adult women and men are about equally likely to use the Internet [Dholakia et al., 2003] or e-mail [Gefen and Straub, 1998]. Culturally-distinctive variation is noted globally in Internet usage patterns [Dholakia et al., 2003]. Gender is also associated with differences in the reasons for or purpose of the use [Gefen and Straub, 1998].

Early studies of computer use found that boys generally spent more time online (usually linked to game use), but if age is considered, differences do take on different patterns. For example, in one study, young girls (before the fourth through seventh grades) actually spent more time on computers than boys, after which girls' usage dropped off [Swanson and Miller, 1998].

Like other recent studies, Subrahmanyam and Lin [2007] found no gender gap in teenagers' home-based access to the Internet (87.8 percent of respondents) or the amount of time spent online (eighty-five minutes per day, or nine and three-fourth hours per week) or on e-mail (twenty-five minutes per day or two hours and fifty minutes per week). Almost half (40.4 percent) of respondents had access to the Internet in their room. They call for further research to study adolescent use of multiple simultaneous online activities as e-mail and Internet surfing alone do not account for social patterns (e.g., loneliness) among the high school-aged teens they studied. The most recent Pew report on teen use of technology states that 75 percent of teens own cell phones, and 93 percent of them go online regularly, so barriers to access have virtually disappeared [Lenhart et al., 2010]. With the recent influx of new technologies and alternative communication applications like text messaging, IMs, Twitter, and social networking, these trends are rapidly becoming more complex and will continue to change our conception of adolescent behavior around technology.

The academic literature on teenage technology use [cf. Gurer and Camp, 2002] has mostly concentrated on social factors when examining gender or age-related differences in usage patterns or technology preferences. Punamaki et al. [2007] found age- and gender-related differences in the use of computers for entertainment, with boys exhibiting higher usage levels for playing digital games, writing, e-mail, and Internet surfing at ages fourteen, sixteen, and eighteen. Interestingly, there were no differences (other than for gaming) between twelve-year-old girls and boys. Mobile phone usage patterns were the converse, with girls using mobile phones more often than boys at a time when most teenagers used a family-shared mobile phone. (Only a few percent of respondents owned their own phone in their sample.) In a more recent survey of 1,000 British adolescents between eleven and sixteen years old, Sacco [2008] found that 38 percent of young girls are daily users of social networking, online games, and mobile downloads, and fully 90 percent of the girls thought technology was "cool." Yet twice as many boys than girls of this group were considering a technology career.

Some of the most detailed analyses of usage patterns were documented in a series of studies by the Pew Internet & American Life Project [Lenhart, 2005; Lenhart et al., 2005; Lenhart et al., 2010]. They found that girls were more likely to send or receive e-mail and text messages than boys, and surf the Web for entertainment, schools to attend, health or fitness information. Both genders about equally sent IMs, bought things online, and researched current events, politics, religion, or jobs. Boys, as might be expected, played more games online than girls. When these same activities were examined by age grouping (ages twelve–fourteen vs. fifteen–eighteen), younger teens were more likely to play games, older teens were more likely to use e-mail, text messages, and IM, buy things online, and research schools, health, jobs, fitness, and current events, with the remainder equivalent across age groups. The most recent Pew study reports that almost two-thirds of teens rely on the Internet for news about current events and politics, and teen use of social media has risen to 73 percent of "wired" teens in 2009 compared to 55 percent in 2006, demonstrating how information technology has taken central stage for teenage communication and information sharing [Lenhart et al., 2010]. They also report that while teens are not great users of Twitter, high school girls are more likely to tweet than boys. What is missing from this vein of research is the link between these differences in preferences and usage patterns and the academic choices teens make around technology.

There are many studies about how girls and boys learn differently, or respond to teaching styles differently, or are treated differently in the classroom [c.f., AAUW, 2004; Cooper and Weaver, 2003]. Silverman and Pritchard [1993] noted that both genders enjoy taking computer courses for similar reasons, yet boys were more likely to enroll in them. Other studies report that boys are more confident and behave more proactively in technology classes, while girls are more likely to watch passively. Families and teachers also demonstrate gender biases, often unconsciously. For example, Swanson and Miller [1998] noted that parents were twice as likely to purchase technology for sons

over daughters. Parents are also more likely to impose Internet use rules on girls than boys, and on younger teens than older ones [Lenhart, 2005]. It is not surprising, then, that recommendations for reaching out to girls include different forms of controlling the social and educational environment and aim mostly to mitigate gender differences in overall technology self-confidence [Dholakia et al., 2003].

There is also evidence that children form opinions about the desirability of taking IT courses early in life, and that waiting until they enroll at a university to introduce the career choice will lessen the possibility of selecting an IT major. Rowan and Bigum [2010] note that students enter secondary school thinking they have sufficient knowledge about IT and studying it in courses would be a "waste of time," or if selected, "easy," and that the study of IT is both boring and too theoretical. Rather, students felt their IT skill base adequate, based on knowledge obtained during earlier school years and via home use.

Given recent advances in ownership and uses of technology by teenagers in middle and high school years, there are more opportunities than ever to either attract or dissuade children from careers in a computing field, Teenagers today are very comfortable with a range of technologies and use an array of them in everyday academic and social situations. These technologies can fade into the background like many other commodity items they use daily, or they can serve as the cornerstone of new curricular activity aimed at persuading students about the attractiveness and viability of an IT career. The aim of this paper is thus twofold: it will first document teenage technology usage patterns to reflect current activities and preferences. Our second goal is to link these patterns to other personal and family factors that might help those attempting to attract today's youth into IT careers identify the right "hooks" for reaching both boys and girls.

III. METHOD

Our 2007 survey of adolescent computer activity was conducted in a cross-section of middle and upper-middle class teenage students. The study aims to identify gender and age group differences in technology-use choices. The survey captures demographic data, different electronic devices ownership, self-assessment of own technical ability, and attitudes toward computer literacy and toward the ways it is taught in school. The main focus is on teenagers' everyday activities, both computer-related and non-computer-related.

Table 1: Demographic Description of the Sample

Demographic characteristic	Percent of respondents
Male Female	38.0% 62.0%
Middle School High School	19.5% 80.5%
Middle School % boys Middle school % girls	40.7% 59.3%
High school % boys High school % girls	37.3% 62.7%
Age 11 Age 12 Age 13 Age 14 Age 15 Age 16 Age 17 Age 18 Age 19	1.0% 5.6% 5.6% 7.9% 12.5% 18.8% 22.4% 24.8% 1.3%
Single child Has older siblings Has younger siblings	10.6% 50.8% 59.1%
Percent with Internet in their home	99.0%

A survey instrument was created to obtain anonymous demographic and self-report data from a large number of male and female respondents. Data for this study was collected by a combination of Web-based and paper surveys. The paper survey consisted of a printout of the Web survey generated using Perseus. Appendix A gives the list of items covered by the survey.

The population of interest for this study is teenagers in middle and high school. Permission was obtained to administer the survey locally at one public and one private middle school, and one private high school. Surveys were distributed in several classes at each of the participating schools. No incentives were given to induce participation, which was elective on the part of the students. Students at three local public high schools were also contacted informally. In addition, a link to the survey was put up on Facebook to obtain additional responses from other locales.

The survey was pretested on a small number of high school students, with only minor changes resulting. Both online and paper surveys were administered in May, 2007. Online responses were obtained from 151 teenagers representing forty-four schools from six states. Paper surveys were administered at the three local schools, from which 160 surveys resulted. After removing problematic surveys, 303 usable surveys remained upon which the following analysis was conducted. Table 1 contains a demographic description of the survey respondents.

IV. ANALYSIS

Data analysis occurred in several steps. Initial t-tests and correlation tables were run to identify significant differences among respondents related to gender, age, and level of school (middle school vs. high school). Because of the wide variance in ages represented in the sample, there are not enough respondents at each age to test for differences at each age level. As a result, we report only on differences based on level of school, as there are adequate numbers of middle and high school respondents to assess significant differences in their responses, and level of school is a strong indicator of relative age when using this method of splitting the data set. In a few cases (as indicated in the results reported in Table 2), the results of a Levene's test indicated that the groups under study had unequal variances. These t-tests, which were re-computed without the assumption of equal variances, are in red in the following tables. In no cases do these adjustments affect the significance of the results.

Based on the questions raised in the literature review and the results of the initial analysis, we first tested whether gender and/or school level drive differences in ownership of technology, types and extent of technology use, or educational opinions about technology. Table 2 reports on those factors for which significant differences are noted based on gender, school level, or a combination of both. In this table, pink indicates items for which girls' responses were significantly higher, and blue indicates that boys' responses were significantly higher. The total columns at the right reflect gender differences regardless of school level.

These results show that there are differences in the amount of time boys and girls spend using technology, and also differences in how they choose to use technology. Differences are less evident in middle school, although this may be due to unequal sample sizes. As expected, boys are more likely to own computer game devices, although both girls and boys in middle school report having gaming consoles in their homes. Surprisingly, girls are more likely to own computers in middle school, but by high school more boys own computers. Overall, high school boys have access to more technology, and use it more than do younger boys. Although boys are more likely to spend a great deal of time on computer games at both levels of schooling, generally speaking, girls and boys exhibit similar usage patterns in middle school years. It is not until high school that we note heavier use of several applications by girls for entertainment or social purposes.

Preferred Applications

Girls and boys in middle school use computers about the same amount of time. By high school, girls spent more time on computers than boys, but only on weekdays. Nonparametric tests were conducted to separate out relative frequency of use from the number of hours each respondent spent on each application. Usage data was re-coded to rank the applications used most frequently to least frequently for each respondent, thus permitting analysis based on ranked preferences rather than reported number of hours spent on each activity (e.g., if respondent A used IM 2–4 hours per day and everything else for less time, and respondent B used IM more than 8 hours a day and everything else for less time, both would receive a rank of 1 for IM). Average ranks are given in Tables 3, 4a, and 5a. These ranks were then tested using the Mann-Whitney U and Wilcoxon W two-independent samples tests. The items with statistically significant differences between genders are marked in bold. Tables 4b and 5b report the analysis for weekday and weekend application preferences, respectively. E-mail and IM were the only activities ranked similarly by both genders during the week; on the weekend, the Web was the only activity both ranked similarly. Girls and boys prefer different activities even when the amount of computer time spent on each is not considered.

Table 2: Significant Differences Due to Gender and/or Level of School									
	MIDDLE SCHOOL			HIGH SCHOOL			TOTAL		
	Boys (24)	Girls (35)	t-test sig. (2-tailed)	Boys (91)	Girls (153)	t-test sig. (2-tailed)	Boys (115)	Girls (188)	t-test sig. (2-tailed)
PDA	0.38	0.343	0.804	0.429	0.279	0.020	0.417	0.287	0.023
Router	0.708	0.743	0.774	0.846	0.675	0.002	0.817	0.686	0.009
Game Console	0.792	0.743	0.672	0.923	0.675	0.000	0.896	0.686	0.000
Room TV set	0.458	0.286	0.189	0.462	0.331	0.046	0.461	0.319	0.015
Room Game Console	0.417	0.257	0.216	0.352	0.123	0.000	0.365	0.149	0.000
Own Computer	0.458	0.771	0.017	0.736	0.686	0.09	0.678	0.702	0.663
Own Game Device	0.792	0.514	0.025	0.440	0.234	0.001	0.513	0.287	0.000
Books Read	3.583	5.286	0.001	3.451	3.877	0.044	3.478	4.154	0.001
Homework (w-day)	3.167	3.353	0.449	3.110	3.503	0.007	3.122	3.462	0.007
Homework (w-end)	2.375	2.571	0.507	2.857	3.333	0.004	2.757	3.187	0.003
Total Computer Use (w-day)	3.167	3.000	0.540	3.703	3.994	0.021	3.591	3.803	0.078
IM (w-day)	2.708	2.514	0.612	2.900	3.305	0.021	2.860	3.144	0.077
IM (w-end)	2.739	2.657	0.843	2.934	3.409	0.010	2.895	3.255	0.033
Games (w-day)	2.208	1.857	0.231	2.100	1.307	0.000	2.123	1.412	0.000
Games (w-end)	2.583	1.829	0.019	2.418	1.362	0.000	2.452	1.452	0.000
Social Networks (w-day)	1.500	1.571	0.756	2.681	3.151	0.002	2.435	2.849	0.004
Computer Homework (w-day)	2.250	2.486	0.402	2.802	3.131	0.011	2.687	3.011	0.007
Computer Homework (w-end)	2.375	2.429	0.854	2.633	2.921	0.020	2.579	2.823	0.036

Table 3: Ranked Weekday Preferences by Gender, All Respondents (Average Rank in Parentheses, 1 = Most Use, 6 = Least Use)	
Boys (113)	Girls (182)
IM (2.87)	IM (2.60)
Computer Homework (3.11)	**Computer Homework (2.69)**
Web (3.12)	**Social Networks (3.03)**
Social Networks (3.60)	**Web (3.39)**
Games (4.10)	E-mail (4.03)
E-mail (4.21)	**Games (5.25)**

Table 4a: Ranked Weekday Preferences by Gender, by School Level. (Average Rank In Parentheses, 1 = Most Use, 6 = Least Use)			
Middle School		High School	
Boys	Girls	Boys	Girls
IM (2.79)	Computer Homework (2.74)	IM (2.89)	IM (2.56)
Web (2.88)	IM (2.78)	**Computer Homework (3.05)**	**Computer Homework (2.68)**
Games (3.25)	Web (3.00)	Web (3.18)	**Social Networks (2.68)**
Computer Homework (3.33)	E-mail (3.96)	**Social Networks (3.33)**	Web (3.48)
E-mail (4.17)	Games (3.97)	E-mail (4.22)	E-mail (4.04)
Social Networks (4.63)	Social Networks (4.56)	**Games (4.33)**	**Games (5.54)**

Table 4b: Significance of Non-Parametric Tests by School Level, Weekdays			
Weekday rankings	Middle School	High School	Total
IM	0.732	0.136	0.126
Computer Homework	0.221	0.048	0.019
Social Networks	0.961	0.000	0.001
Web	0.614	0.076	0.048
E-mail	0.514	0.110	0.089
Games	0.094	0.000	0.000

Table 5a: Ranked Weekday Preferences by Gender, by School Level (Average Rank In Parentheses, 1 = Most Use, 5 = Least Use)			
Middle School		High School	
Boys	Girls	Boys	Girls
Web (2.26)	IM (2.49)	**IM (2.54)**	**IM (2.04)**
IM (2.72)	Web (2.53)	Web (2.58)	**Computer Homework (2.43)**
Games (2.78)	Computer Homework (2.79)	**Computer Homework (2.88)**	Web (2.76)
Computer Homework (3.22)	E-mail (3.51)	**Games (3.35)**	**E-mail (3.21)**
E-mail (3.93)	**Games (3.68)**	**E-mail (3.61)**	**Games (4.55)**

Table 5b: Significance of Non-Parametric Tests by School Level, Weekends			
Weekday rankings	Middle School	High School	Total
IM	0.370	0.002	0.001
Computer Homework	0.102	0.002	0.000
Web	0.414	0.152	0.088
E-mail	0.066	0.001	0.000
Games	0.040	0.000	0.000

Homework Patterns

We next looked at how computers are used in light of overall homework patterns. No significant differences are noted in the amount of time middle school boys and girls spend on homework during the week or over the weekend (See Table 2). Once in high school, girls spend more time on homework than boys. In reporting how often they hand-write homework, there is no gender difference noted; however, the frequency of handwriting homework assignments drops dramatically between middle school and high school respondents, especially among girls (see Tables 6a and 6b). Both genders use computers to help with homework at about the same level in middle school. Both genders use their computer more for homework during the week in high school than they did in middle school, although by high school, girls are using theirs more for homework than boys. In fact, girls in high school generally use computers more than boys, which shows that usage itself does not appear to be an impediment for academic work with IT.

Table 6a: Non-Computer Activity by School Level									
	Middle School			High School			Total		
	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.
Non-Computer Activity index 1	17.04	18.43	0.057	16.64	17.27	0.166	16.72	17.49	0.062
Non-Computer Activity index 2	21.38	23.40	0.044	20.22	20.95	0.170	20.46	21.41	0.045

Table 6b: Non-Computer Activity By Gender									
	Boys			Girls			Total		
	Middle School	High School	t-test sig.	Middle School	High School	t-test sig.	Middle School	High School	t-test sig.
Non-Computer Activity index 1	17.04	16.64	0.631	18.43	17.27	0.016	17.86	17.03	0.085
Non-Computer Activity index 2	21.38	20.22	0.230	23.40	20.95	0.000	22.58	20.68	0.001

Non-Computer Activities

Given the finite amount of time students have for afterschool and weekend activity, differences in computer-related activity levels might be due to commitments to or preferences for extracurricular activities that are not dependent upon using a computer, such as sports, being outdoors, chores, or reading. The respondents were also asked to estimate the amount of time spent on nonacademic activities. A Non-computer Activity Index (#1) was computed from the responses to questions about these other activities, including questions about participation on organized sports teams, pleasure reading, time spent outside for non-team activities, and extracurricular socialization. A second Non-computer Activity Index (#2) also adds in the response to the question about the frequency with which the respondent hand-writes homework papers. Differences due to school level and gender are reported in Tables 6a

and 6b. Differences in non-computer activity are more pronounced in middle school than in high school. However, in general, girls report spending more time on non-computer activities than boys, especially noting that they are more likely to hand-write homework. An interesting finding is that girls also read more books than boys at both levels (see Table 2), but the number of books girls read drops significantly by high school, which is in line with reading habits noted by Karim and Hasan [2007].

Computer Ownership Patterns

A series of indices were created to reflect the level of technology ownership by the respondent and the respondent's family that might help explain respondents' computer usage patterns. The composition of these indices is shown in Appendix A. Gender and school level differences for these indices are reported in Table 7.

Table 7: Differences in Technology Ownership by Respondents and their Families

	Middle School			High School			Total		
	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.
Hi Tech Home Index1	7.958	8.286	0.555	8.473	7.876	0.003	8.365	7.952	0.034
Hi Tech Home Index2	20.417	19.857	0.754	20.044	18.812	0.031	20.122	19.011	0.045
Hi Tech Room Index	1.583	1.257	0.376	1.758	1.268	0.011	1.722	1.266	0.007
Hi Tech Kid Index	4.250	4.229	0.969	4.824	4.085	0.005	4.704	4.112	0.014

In general, boys own more technology and have access to more technology in their homes. However, these differences do not become pronounced until high school. Much of this is driven by previously noted differences in game console ownership by high school boys, although high school boys are also more likely to own or have access to specific other technologies in their rooms. When the technology ownership indices are recomputed after dropping game consoles and devices from the relevant indices, all indices are no longer significantly different between genders or school levels, with the sole exception of Hi Tech Index1, where high school boys still have access to more technology.

Table 8: Satisfaction with Home Computer Access

		Gender			School Level			Total
		Boys	Girls		Middle School	High School		
		%	%	Chi-sq. sig.	%	%	Chi-sq. sig.	%
Technically advanced computer	Yes	70.4	76.6	.234	64.4	76.6	.054	74.3
	No	23.5	17.0	.168	18.6	19.7	.858	19.5
	Unsure	6.1	6.4	.918	16.9	3.7	.000	6.3
Computer usage rules in the home	Yes	18.3	12.8	.192	35.6	9.8	.000	14.9
	Yes but not followed	12.2	15.4	.431	23.7	11.9	.019	14.2
	No	69.6	71.8	.676	40.7	78.3	.000	71.0
Desire more time with technology	Yes	35.7	38.3	.659	62.7	31.1	.000	37.3
	No	63.5	61.2		37.3	68.0		62.0

High school students tend to be more satisfied with how technically advanced their computer is, although a significant proportion of middle schoolers were unsure how technically advanced their machine is. There are no other gender or school level differences in satisfaction with their technology.

About a third of both boys and girls acknowledged that there were rules imposed on them regulating their TV/computer usage at home, although most of the rules fell away once they were in high school. Interestingly, about half of those reporting the existence of rules said they did not follow them. However, this did not equate to them spending as much time as they want on their computers, as most middle schoolers and about a third of high school students would choose to spend more time with their technology if they could find the time or if house rules were relaxed.

Computer Knowledge

Respondents were also asked to evaluate their own technical ability and satisfaction with their computer skills (see Table 9). Boys reported a higher level of technical ability than girls, although middle school responses were not statistically different. It wasn't until high school that boys' self-assessment exceeded girls'. In fact, girls' self assessment goes down marginally by high school. Interestingly, both genders were satisfied with their level of technical ability, and their level of satisfaction did not change in high school. Boys were more likely to report that they knew all that they needed to know about computers than girls, but this difference was not evident when examined at the school level.

Table 9: Computer Knowledge Self-Report

	Middle School			High School			Total		
	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.	Boys	Girls	t-test sig.
Technical Ability Assessment	3.71	3.60	.526	3.77	3.52	.002	3.76	3.54	.003
Satisfied with Technical Ability	2.00	1.91	.497	1.98	1.89	.189	1.98	1.89	.130
	Boys	Girls	Chi-sq. sig.	Boys	Girls	Chi-sq. sig.	Boys	Girls	Chi-sq.sig.
Adequate Computer Knowledge	17%	3%	.061	13%	7%	0.079	14%	6%	0.017

Computer Coursework

Respondents were then asked several questions about the adequacy of the computer courses offered at their school (see Table 10). Middle school girls were happier with the computer courses offered than boys were, although it is not clear if this is because they liked the courses offered or if they didn't care what they contained. Although the differences between genders remained non-significant, by high school, boys' level of satisfaction with course offerings increased considerably and surpassed girls',[3] while girls were about the same. High school girls were also more likely to be unaware of computer courses offered in their schools.

Table 11 reports on student recommendations on changes to computer course offerings. When asked how their school could improve its technology education program, almost two-thirds of the students responded that they did not care or that the courses were fine the way they are. Of those with opinions on how to improve course offerings, the most popular answer is to increase the variety of courses. High school students of both genders were more likely to recommend offering more levels of difficulty in the courses.

Table 10: Satisfaction with School Computer Courses

	Middle School			High School			Total		
	Boys	Girls	Chi-sq. sig.	Boys	Girls	Chi-sq. sig.	Boys	Girls	Chi-sq. sig.
Satisfied with School course offerings	46%	69%	.081	76%	66%	.107	70%	66%	.580
Unaware of school course offerings	17%	14%	0.803	12%	24%	.022	13%	22%	.035

[3] The Chi square statistic for at increase in boys is .005. No other gender differences are significant with respect to school course offerings.

Table 11: Recommendations for Improving School Course Offerings							
	Total	Boys only	Girls only	Chi-sq. sig.	Middle school	High School	Chi-sq. sig.
	%	%	%		%	%	
I don't care	48.8	53.9	45.7	.167	49.2	48.8	.958
More variety	21.5	20	22.3	.630	25.4	20.5	.408
More levels of difficulty	13.5	9.6	16	.114	6.8	15.2	.091
Quality of classes must improve	11.2	13	10.1	.432	10.2	11.5	.775
They are fine the way they are	17.5	13	20.2	.111	18.6	17.2	.795
Other	4.6	7	3.2		8.5	3.7	

V. DISCUSSION

Our goal in this study is to tease out those factors that might explain the propensity of teenagers to use or choose to study technology, such as the variables describing access to technology in the home or at school, or family member computer expertise. The analysis of more than 300 completed surveys reveals both similarities and differences in male and female elective technology use. Of particular note is that many of the gender-related differences do not appear until high school. This signals that students must be made aware of the importance and benefits of computing technology for purposes other than leisure or social interaction in the lower grades, and also in the home.

There are also significant differences in gender-based usage patterns and perspectives on computing. Girls are more likely to use technology for communication, while boys tend to opt for computer as entertainment. Girls spend more time on homework than boys, and they also use their computer for homework more once they get to high school. In middle schools, both genders assess their technical ability the same, but by high school, boys report a higher level of ability than girls and also know more about the computer curriculum in their high school. So while girls seem to be very comfortable using computers for school work, they do not feel they have learned all they need to know, yet are less aware of what courses their school offers them than high school boys. Clearly there is opportunity for schools to improve the way they reach out to female students.

Cooper and Weaver [2003] point to several factors that contribute to girls' computer anxiety, including peers, teachers, parents, classroom structure, and the individual student's own expectations, identification, and performance. These factors are said to lead the student to develop his or her attitude toward computers, which will directly affect course and major selection decisions. They suggest several actions parents and schools can take to ameliorate student computer anxiety. Their suggestions predate the pervasive reliance on technology among the generation of students we sampled. That said, some of their suggestions seem to have been adopted by the families of the students in our sample, while others seem outdated given the advances made in social networking technologies that were not in use at the time of their writing. Many of their recommendations pertain to equal access to computers at home and school, teacher training, and cooperative or single-sex learning environments.

Virtually all of the students in our sample had Internet access in their homes, an indication of the widespread access this group enjoys. Of note, we observed equal level of technology access in middle school homes, yet boys garnered greater home access to assorted technology in high school. This may be the result of stereotyping coming into play as students age (from their peers, their teachers, or their families), greater interest by boys in the specific technologies covered by our survey (a byproduct of our survey design), or girls engaging in more non-computer activities than boys in their limited leisure time (student identification with a preferred set of extracurricular activities). The stereotype of boys using technology for gaming did not bear up in the younger respondents, yet by high school girls had replaced much of their gaming time with social networking, and the differential stereotype resumed. These findings are consistent with other studies that found that boys and girls diverge in their game-playing and social networking patterns as they age [cf., the large National Center for Education Statistics 2004 study referenced by Barker and Aspray, 2008].

There is considerable research on teacher training issues throughout the IT education literature [see the review chapters in Cooper and Weaver, 2003, and Cohoon and Aspray, 2008]. We note that there is much anecdotal and research evidence that many good teachers do not have adequate IT knowledge to comfortably incorporate IT into their courses, and IT teachers frequently do not have formal educational preparation or experience in addressing gender computer anxiety and preference differences to maximize the learning experience for both genders. This holds true also at the university level, where new programs on game design are taught by faculty who did not grow

up immersed in gaming like today's students, and have little experience with gender differences in gaming [Sung, 2009]. Even in high schools, computer instructors have been teaching for a long period of time and are "old" by teenage standards, and the need for training to update their IT skills to keep pace with rapidly changing technology is considered a top challenge [CSTA, 2009]. Given our focus on students rather than teachers, our data does not specifically inform the educator audience about how to respond to our findings. Rather, our goal is to illustrate the strength and evolution of gender differences so that teachers become aware of how technology is used and perceived by those sitting in the classroom, and can seek out ways to attract and retain student interest in IT courses and careers.

Cooper and Weaver's [2003] single sex classroom recommendation would seem to counter efforts to equalize access to technology at school. They reviewed a wide range of research on single-sex classrooms and found many benefits and drawbacks to them. These do appeal to some female students, as was the case in the study by Carmichael [2008] about a weeklong game design course open only to girls in eighth and ninth grades. Of the twelve girls in the course, seven noted that they were more likely to enroll in a high school IT course because of the experience. Other high schools have worked hard to alter course content so that male-oriented tools and techniques do not dissuade girls from taking or excelling in computer classes. Some high schools have begun to reach out to girls in order to increase their interest in the computer-related curriculum [Barker et al., 2008]. Thus, there appear to be alternative methods in play for successfully attracting girls to technology courses and careers.

Although we did not explicitly survey single-sex classes or instructional preferences, we noted no significant difference between genders in their recommendations for improving the IT curriculum in their school. This may be good or bad news—either current courses meet gender-centric needs well enough and everyone is happy with the status quo, or both genders don't care about the courses offered and would not attracted by any changes (as is implied by the majority who replied in this way when asked how to improve the curriculum). Families, schools, and peers are all capable of providing role models for students as they ponder their relationship with IT as something more than a plaything. The National Center for Women and Information Technology (NCWIT) has joined with over twenty organizations to provide resources and support for students and teachers in the K–12 years [Wilson and Harsha, 2009]. All of these influential groups must take on the responsibility for guiding students into making informed decisions about IT education and careers.

VI. CONCLUSION

The descriptive results here correspond well to gender and age differences noted by other researchers. Our focus on linking the quantity of use to scholastic and extracurricular activity extends our understanding of the patterns of teenage technology use as it develops throughout pre-university years.

As is the case with any survey, this study is subject to several limitations. The paper survey was distributed to a convenience sample representing schools in a limited geographic area. We included public schools in mid- to upper-class suburbs and a private school in an urban setting that attracts students from many surrounding towns and several countries. The online survey, while open to any age-qualified respondent, was biased toward technologically savvy students, as it was distributed only over Facebook. Given the widespread use of social networking software among today's teens, this may not cause as strong a bias as it would if the intended respondent population were adults. Another limitation is the small sample size. While 303 respondents allows us to conduct a wide range of analyses, the uneven response rates among ages limits more detailed analysis based on age. In addition, the high school sample is several times larger than the middle school sample, which may account for differences in the power of the significance of the results. Finally, the data was collected anonymously at a single point in time from pre-college age students. Thus, we cannot link our survey results with the college plans and technology skills of this same sample of students. A longitudinal study would be needed to link middle and high school usage patterns to actual choice of college major and career paths.

The results presented in this paper provide a step forward in addressing gender differences in perceptions, habits, and interests in computer and communication technologies. There is clearly an educational need for IT educators at all levels to better understand how the genders differ with respect to their attitudes toward and interest in computing careers, and there is also a training need for teachers at all levels to maintain an understanding of the current computing skill set of the students sitting in their classroom. This is both an opportunity for educators and a burden, as both the gender-specific preferences and student experience and interests evolve faster than most IT curriculum. Finally, we intend that the dissemination of our results will encourage broadly based conversation around gender preferences with respect to home and school-based elective computer use, with the aim of providing input to those overseeing educational curricula and policies, classroom software design and career counseling.

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Editor's Note: The following reference list contains hyperlinks to World Wide Web pages. Readers who have the ability to access the Web directly from their word processor or are reading the paper on the Web, can gain direct access to these linked references. Readers are warned, however, that:

1. These links existed as of the date of publication but are not guaranteed to be working thereafter.
2. The contents of Web pages may change over time. Where version information is provided in the References, different versions may not contain the information or the conclusions referenced.
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APPENDIX A

DEFINITIONS OF DATA ITEMS IN SURVEY INSTRUMENT AND INDICES CREATED FOR ANALYSIS

Abbreviation used in analysis	Question in survey	Values
Age	How old are you?	11–19
School	What school do you go to?	Open-ended
Town	What town do you live in?	Open-ended
Net Home	Do you have the Internet at your home?	Yes/No
Net Access	Where do you use the computer the most?	Home, School, Work or Other (open-ended)
FAMILY OWNERSHIP		
Desktop	Desktop Computer	Yes/No
Laptop	Laptop	
TV set	TV set	
Cell phone	Cell phone	
MP3 player	Ipod/MP3 player	
Cable TV	Cable/Satellite TV	
PDA	PDA	
Router	Router	
Game Device	Game Device	
Game Console	Game Console	
Hi Tech Home Index1	*Sum of all answers for family ownership questions*	*1–10*
TECHNOLOGY IN RESPONDENT'S ROOM		
Room Desktop	Desktop Computer	Yes/No
Room Laptop	Laptop	
Room TV set	TV set	
Room Cable TV	Cable/Satellite TV	
Room Game Console	Game Console	
Hi Tech Room Index	*Sum of all answers for room ownership questions*	*0–5*
RESPONDENT OWNERSHIP		
Own Cell phone	Cell Phone	Yes/No
Own MP3 Player	Ipod/MP3 player	
Own Computer	Computer	
Own PDA	PDA	
Own Game Device	Game Device	
Hi Tech Kid Index	*Sum of Hi Tech Room Index and all answers for respondent ownership questions*	*0–10*
TECHNOLOGY QUANTITY		
Number of Computers	Computer (both desktop and laptop)	0–11
Number of TVs	TVs	0–10
Number of Cell Phones	Cell Phones	0–14
Hi Tech Home Index2	*Sum of Hi Tech Home Index1 and all answers for technology quantity questions*	*1–37*
ACTIVITIES QUESTIONS		
Going Out	How often do you go outside for at least 30 minutes for anything other than an organized sports team?	1—never 2—rarely 3—once a week or only weekend 4—only weekdays 5—a few times a week or every other day 6—every day (once or more)
Sport	How often do you go outside for at least 30 minutes for an organized sports team?	

Abbreviation used in analysis	Question in survey	Values
Books Read	How many books have you read, other than ones assigned as school work, in the last year?	1 – 0 2 – 1 3 – 2–4 4 – 5-9 5 – 10–14 6 – 15–20 7 – 21+
Socialization	On average how many hours per week do you spend doing social activities with your friends outside of school?	1 – 1 or less 2 – 1–2 3 – 3–5 4 – 6–10 5 – 11–15 6 – 16–20 7 – 21+
Handwritten	How long ago was the last time you hand wrote a paper, of more than half a page, at home, to be passed in for a grade?	1 – more than 2 years 2 – 1–2 years 3 – 6 months–1 year 4 – 2–6 months 5 – 1–3 months 6 – < 1 month
Homework (w-day)	On average how much time do you spend on homework on a week day?	1 – none 2 – less than 1 hour 3 – 1–2 hours 4 – 2–4 hours 5 – 4–8 hours 6 – more than 8 hrs.
Homework (w-end)	– " – on a weekend day?	
Total Computer Use (w-day)	On average how many hours per day do you spend on the computer on a typical week day?	1 – none 2 – less than 1 hour 3 – 1–2 hours 4 – 2–4 hours 5 – 4–8 hours 6 – more than 8 hours
Total Computer Use (w-end)	– " – on a weekend day?	
E-mail (w-day)	On average how many hours per day do you spend on e-mail on a typical weekday day?	
E-mail (w-end)	– " – on a weekend day?	
IM (w-day)	On average how many hours per day do you spend on Instant Messaging Programs such as AIM or MSN on a typical weekday?	
IM (w-end)	– " – on a weekend day?	
Games (w-day)	On average how many hours per day do you spend on computer games on a typical weekday?	
Games (w-end)	– " – on a weekend day?	
Social Networks (w-day)	On average how many hours per day do you spend on social networks such as Facebook or MySpace on a typical weekday?	
Computer Homework (w-day)	On average how many hours per day do you spend doing school work on a computer on a typical weekday?	
Computer Homework (w-end)	– " – on a weekend day?	
Web (w-day)	On average how many hours per day do you spend "surfing" the web on a typical weekday?	
Web (w-end)	– " – on a weekend day?	
What types of files do you download?		
Download music	Music	Yes/No
Download games	Games	
Download software	Software Updates	
Download video	Videos	
Download pictures	Pictures	
Download podcasts	Podcasts	
Download other	Other (open ended)	Open-ended
Download nothing	None (nothing downloaded)	Yes/No

Abbreviation used in analysis	Question in survey	Values
Files per Week Download	How many files do you download per week? (open-ended)	0–300
Self Tech Ability	How technically able are you?	1 – "Can't do anything" 2 – "Need help with simple tasks" 3 – "Can perform simple tasks" 4 – "Very able, can deal with most computer problems" 5 – "Expert"
Self Tech Ability Satisfaction	How satisfied are you with your computer knowledge?	1 – " I need to know more"; 2 – "I am OK with what I know"; 3 – "There is not much more I could know about computers"
Need to Know More	Dummy coding of previous question	1 if SelfSatTechAb = 1 0 otherwise
Know Everything		1 if SelfSatTechAb = 3; 0 otherwise
School Satisfaction	Does your school offer enough technology education courses?	1 – "Yes" 2 – "No" 3 – "I don't know what my school offers"
School Satisfaction Yes	Dummy coding of previous question	1 if SelfSatTechAb = 1 0 otherwise
School Satisfaction Don't Know		1 if SelfSatTechAb = 3 0 otherwise
How can your school improve its' technology education?		
Sch Don't Care	I don't care	Yes/No
Sch More Variety	More variety	
Sch More Levels	More levels of difficulty	
Sch Quality	Quality of classes must improve	
Sch OK	They are fine the way they are	
Sch Other	Other	Open-ended
Older Siblings	How many siblings do you have? Older (open-ended) Younger (two open-ended)	0–7
Young Siblings		0–5
Single Child	Dummy for single children	1 or 0 (yes/no)
Mother Tech Ability	How technically able is your mother/guardian	1 – "Can't do anything" 2 – "Need help with simple tasks" 3 – "Can perform simple tasks" 4 – "Very able, can deal with most computer problems" 5 – "Expert"
Father Tech Ability	How technically able is your father/guardian	
Older Sib Tech Ability	How technically able are your older siblings?	
Younger Sib Tech Ability	How technically able are your younger siblings?	
Advanced Computer	Is the computer you use technically advanced enough to do everything you want to do?	Yes/No/I don't know
Computer Rules	Are there rules regulating your TV/Computer usage at home?	Yes/No/Yes, but no one follows them
More Time	Would you go online/use computers/watch TV more if you were allowed to or had more time?	Yes/No

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