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STEREOTYPES AND TECHNOLOGY EDUCATION: DIFFERENT PERCEPTIONS OF COMPUTER CAREER AMONG ELEMENTARY SCHOOL STUDENTS

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Abstract. *Prior studies indicated that children's images of science and engineering greatly influenced their attitude toward career choice. This study explored how elementary school students perceived computer professionals and computer job tasks. Sixty-four students attending computer camps in 2 cities participated in the study. The Draw-a-Scientist Test was employed and interviews were performed to collect and analyze student perceptions of computer professionals and computer job tasks. The results indicated that the students held contrasting perceptions of computer professionals. Although some students envisioned computer professionals with stereotypical characteristics, such as poor eyesight and unsociability, many students viewed computer professionals as people who were knowledgeable, mild tempered, and socially attractive. Moreover, students residing in different areas had conflicting perceptions of computer professionals because of personal experience with various types of computer professional. The results suggested that students did not stereotype computer careers according to gender, but female students exhibited a more negative attitude toward computer careers than did male students. To shape student views on computer jobs and career choices effectively, the researchers suggest providing students with learning opportunities in life contexts to understand the nature of computer professions.*
Key words: *career perception, digital divide, gender studies, perception of computer scientists, science and technology education, urban-rural gap.*

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Introduction

Although numerous studies have supported the theory that student perception of scientists influences student attitudes toward scientific and engineering careers, studies have confirmed the existence of a substantial gap between the perceptions that elementary and secondary school pupils hold of a typical scientist and those that they hold of themselves. This gap, which increases with age, might be responsible for the lack of interest expressed by students regarding science and science-related careers (Buck, Clark, Leslie-Pelecky, Lu, & Cerda-Lizarraga, 2008; Mercier, Barron, & O'Connor, 2006; Wyer, 2003). In addition, several studies have applied the social cognitive theory to career development, confirming that early experiences with role models who competently perform skills required by a specific occupation can influence the future career development of students (Betz, 1994; Lent, Brown, & Hackett, 1994). Social cognitive theory suggests that people observe, code, and imitate the behaviors of others. When the person observed has characteristics similar to those of the observers and performs skills competently, the expectations of the observers regarding their own abilities to perform tasks and their desire to act in a certain manner are reinforced (Bandura, 1986, 1989). Therefore, cultural beliefs, which are influenced by stereotypes, may bias self-assessments of task competence and involve opinions concerning who, according to gender, race, or background, is more competent in a specific area (Correll, 2004). These beliefs, formed as early as fourth grade, persist over time and eventually influence career choices (Buck et al., 2008). For example, gender-stereotyped images of scientists have been identified in studies that have examined why women remain highly underrepresented in scientific and engineering fields (Furlong & Biggert, 1999; Gilbert & Calvert, 2003).

To examine the relationship between students' living environments and learning opportunities, Barron (2004, 2006) proposed a learning ecology framework that emphasized the importance of understanding the life contexts and personal experiences of students in relation to technology fields. Mercier et al. (2006) investigated student perceptions of computer professionals in the Silicon Valley region, where many students participating in the research knew family members and friends who worked in technology-related

fields. The results suggested that the middle school students' engagement in technology-related activities was related to personal experiences, perceptions, and identities. The insights provided by previous studies pertaining to the images of scientists and engineers and their professions and the lack of understanding about these images inspired the current investigation of how young children in various environments conceptualize computer professionals and future career possibilities.

Digital divide is commonly seen as a gap in terms of access to and usage of information and communication technology. In fact, the divide may refer to social inequality, between geographic areas or socioeconomic levels, with regard to contextual understanding of technology enterprise. In this study, which was conducted in urban and rural areas, the researchers particularly examined the environmental influences exerted on elementary school students' impressions of computer professionals and IT professions. By exploring the relationships among student perceptions, living environments, and future career preferences, this study will give an insight into the formation of these perceptions and then provide a reference for policy makers developing educational initiatives.

Literature Review

Stereotypes on Scientists and Engineers

Numerous studies have indicated that cultural stereotypes of scientists have been influenced by popular culture or media. Fictional characters in novels, films, or comic books can fuel such stereotypes and may contribute to fears and expectations associated with the image of scientists (Boylan, Hill, & Wallace, 1992; Cheryan, Plaut, Handron, & Hudson, 2013; Frenkel, 1990; Parsons, 1997; Rubin & Cohen, 2003; Wilson, 2002). Although scientists are typically regarded as smart or dedicated, they have frequently been portrayed as grim-looking bespectacled workaholics (Losh, Wilke, & Pop, 2008; Lunn & Noble, 2008; Weingart, Muhl, & Pansegrau, 2003; She, 1998).

For example, high school students inadequately comprehend the nature of IT work, and most high school students assume IT work entails long hours of programming in front of a computer, working in isolation; this image influences student attitudes toward computer careers.

Previous research findings indicate that computer scientists are associated with intelligence, negative social characteristics, and technology (Cheryan et al., 2013; Mercier et al., 2006). Computer professionals and scientists have been branded with a nerdy image in popular culture. Like scientists, computer professionals are frequently depicted as nerds or geeks and possess negative personality characteristics. For example, high school students tend to imagine a computer scientist as an unattractive, pale, thin man who wears glasses (Mercier et al., 2006). Popular media portray a computer scientist as "someone who is highly intelligent, singularly obsessed with computers, and socially unskilled" (Cheryan et al., 2013). Moreover, many students envision computer professionals as stereotypical nerds or overweight geeks (Mercier et al., 2006).

Understanding of the Nature of Scientific Professions

Previous studies have determined that students lack knowledge regarding the work scientists and technologists undertake (Cleaves, 2005; Hill & Wheeler, 1991), affecting the occupational preferences of students. For example, pharmacists and software engineers were not perceived as engaging in scientific work.

Because technology has rapidly developed, the computer industry job market has gained importance and afforded attractive jobs, salaries, and future prospects. The image of the information technology (IT) professional frequently associated with power, mastery, and high social status (Harris & Wilkinson, 2004). Nevertheless, disparity between the supply and demand of computer professionals poses challenges for countries leading technical innovation. Despite the prestige and value of the computer field, enrollment in IT-related majors has dropped substantially in recent years, resulting in a shortage of technical workers (Cheryan et al., 2013; Christensen, Knezek, & Tyler-Wood, 2014; Lasen, 2010). Choudhury, Lopes, and Arthur (2010) attributed the insufficient workforce to misinformation regarding IT careers. Like issues in science education, lack of knowledge regarding computer professions can limit student self-perception of the ability to pursue IT careers. Several studies have suggested that students regard IT professions as "boring," "difficult," and "highly technical," and involving "interacting with computers," working "in isolation," and "programming" (Cheryan et al.; Choudhury et al., 2010; Lasen, 2010; Mercier et al., 2006). Moreover, stereotypes regarding the nature of a job can influence career choices because students consider whether their personality traits and abilities are compatible with these stereotypes (Cheryan et al.). For example, many students

believe that IT careers require excellent mathematical abilities, but do not realize that various positions, such as computer programmers and system analysts, require other skills to manage associated tasks.

Lasen (2010) indicated that insufficient understanding of computer subjects and career pathways causes students to perceive that computer-related jobs comprise boring coding tasks and nothing that can engage the imagination. More importantly, previous studies have suggested that self-perception hinders students who perceive their science or mathematics ability to be inadequate for job requirements from studying science or engineering (Christensen et al., 2014; Cleaves, 2005).

Gender Identity, Social Status, and Career Choice

Gender concerns are frequently addressed to describe the "socially shaped" aspect of technology (Cockburn & Ormrod, 1993). Unequal participation in computer fields has been documented at all levels of education, and few female students engage in technology-related courses in high school and college (Camp, 1997). The fact that many qualified female students do not choose to pursue computer science degrees in college has been attributed to gender stereotyping.

Positive images of scientists and engineers as well as gender equality influence women's commitments to scientific and engineering careers (Wyer, 2003). Students feel encouraged to enter professions when they can identify a role model in that profession. The absence of female teachers and role models, which is related to gender identity, affects how scientists, technologists, and their work are perceived (Buck et al., 2008). For example, girls' perceptions and experiences are reinforced by the fact that the majority of computer courses are taught by men. Therefore, they associate a masculine image with computer professions (Cheryan et al., 2013; Mercier et al., 2006; Schott & Selwyn, 2000). In addition, girl's attitudes are shaped by families, schools, and culture, and their access to and use of computers is frequently limited. Evidence from several studies has confirmed that boys tend to use computers more frequently than do girls. Thus, girls have gradually formed the impression that the computer profession is suited to men, and ultimately, self-efficacy affects their career choices (Cooper & Weaver, 2003; Fan & Li, 2005; Solvberg, 2002).

According to a study on female college students' attitudes toward computers conducted by Fan and Li (2005), female students in Taiwan typically hold the impression that computer professions are male dominated; the number of female students majoring in computer science is far lower than that of male students in Taiwan. Nevertheless, female students perform favourably academically because they have a positive attitude toward computers and are confident in their ability to compete with males. As Correll (2004) asserted, female students must overcome cultural beliefs and, therefore, hold themselves accountable to a higher performance standard.

Educators have recently expressed concern regarding the digital divide, which refers to the gap between those who have access to new IT and those who do not because of economic status, education, or sociodemographic characteristics such as race, gender, and age (Norris, 2001; van Dijk, 2005). Despite increasing resources and opportunities in the digital era, a severe digital divide remains for groups of people who have not benefitted by the technological revolution (Cooper, 2006; Warschauer, 2004). Ethnicity and socioeconomic status, for example, influence the readiness for scientific and engineering careers. Because of a lack of role models or knowledge regarding the technological field, children cannot match the social class reference groups when perceiving the occupational world and evaluating their career choices (Christensen et al., 2014).

Choudhury et al. (2010) held an IT career camp as an early intervention strategy to change student perceptions. The camp activities included visiting MIS departments of corporates and being involved in creating solutions for business problems by using IT, and parents were invited to a session. A corporate representative addressed the need for additional IT talent and job prospects in the field. The research results indicated that student attitudes toward IT careers became more positive. At the beginning of the camp, the interviews revealed that many students began with a stereotyped, unfavourable image of IT professionals. By the end of the camp, however, participants had a dissimilar opinion and no longer regarded IT professionals as geeks. The camp activities increased the students' perceptions of IT work, and they regarded it as interesting, creative, social, and challenging. Many of these findings reiterate the benefits of exposure to scientific or technologic inquiry when students are naturally curious and exhibit a natural inclination to understand the fundamentals of the engineering design process (Christensen et al., 2014).

Methodology of Research

Research Methods

This research is concerned with exploring the perceptions on computer profession and influences of the living environments and, therefore, attention is given to the description and comparison between the students from urban and rural areas. To do this, the qualitative research methods used combines an analysis of student drawings and interviews, statistical techniques by which to reveal relationships or associations between contextual experiences and perception formation.

Procedure

To explore the contextual influence of the living environment, one computer camp was held in an urban area, and the second was located in a rural area. Each camp offered hands-on lessons of software application and lasted for a week. At the beginning of the camp, students were asked to draw a computer expert in his or her mind. Later, each student was interviewed along with one's own drawing during the camp. The data collected would be further analysed.

Without charge for the activities, students first registered and then were selected by school teachers to attend this camp. Informed consents were provided to student parents in order to conform to the ethical guidelines for ensuring that the rights and welfare of research participants to be adequately protected.

Instruments

The research tools and approaches used to collect and analyse data were the Draw-a-Scientist Test (DAST) and interviews. First, students drew a computer professional on a paper. The DAST, developed by Chambers (1983), has been used widely to explore student perceptions of scientists and affords symbolic indications of student beliefs. Since young children's reading skills and expression are limited, DAST have served as proxies for verbal stereotypes about scientists. However, the "priming effects" of the DAST may occur when it is used to research children's image perceptions. For example, children draw figures of the same gender more frequently than they do figures of the other gender because of self-projection (Buldu, 2006; Losh et al., 2008). To resolve the inconsistency that exists between the pictorial representations and authentic thoughts, therefore, the drawings are frequently used as medium for further interviews.

Research Participants

The researchers held computer camps in two cities respectively. The participants comprised fifth- and sixth-grade students who attended computer camps held at two locations in Taiwan. The "urban" group consisted of 19 boys and 12 girls from a school in Taichung City, which is the third-largest city in Taiwan. Located in Central Taiwan, the city has a population of one million and contains numerous science and industrial parks accommodating high-tech companies. By contrast, the "rural" group comprised 16 boys and 17 girls from a school in Chiayi, which has a population of 270,000 residents and is surrounded by rice paddies in Southern Taiwan; the main economic activity in the greater Chiayi area is agriculture. In Taiwan, students begin attending required computer courses in the fourth grade. Most students who participated in this study had advanced knowledge of computers, were interested in using computers, and were chosen to attend the camp according to the recommendation of their teachers.

The research team consisted of one researcher and two elementary school teachers. The elementary school teachers conducted interviews and coding, and the researcher repeatedly examined the data to enhance validity.

Data Collection and Analysis

In order to compare the different perceptions between student groups, qualitative and quantitative research methods were adopted to collect and analyse data on elementary school students' attitudes and perceptions. To

explore student perceptions of computer professionals, the researchers asked each student to draw a computer professional. After analysing and annotating the drawings, the research team members conducted one-on-one interviews to enhance their understanding of the formation of the images. To ensure that the students depicted people who were engaged in computer-related professions, we interchangeably used "computer experts" and "computer professionals" during instruction. Figure 1 shows two of the student drawings. The qualitative data derived from the drawings and interviews were then divided into categories and subjected to statistical analysis. The chi square test was used to determine if there is a significant relationship between perceptual traits and categorical variables such as city of residence and gender.

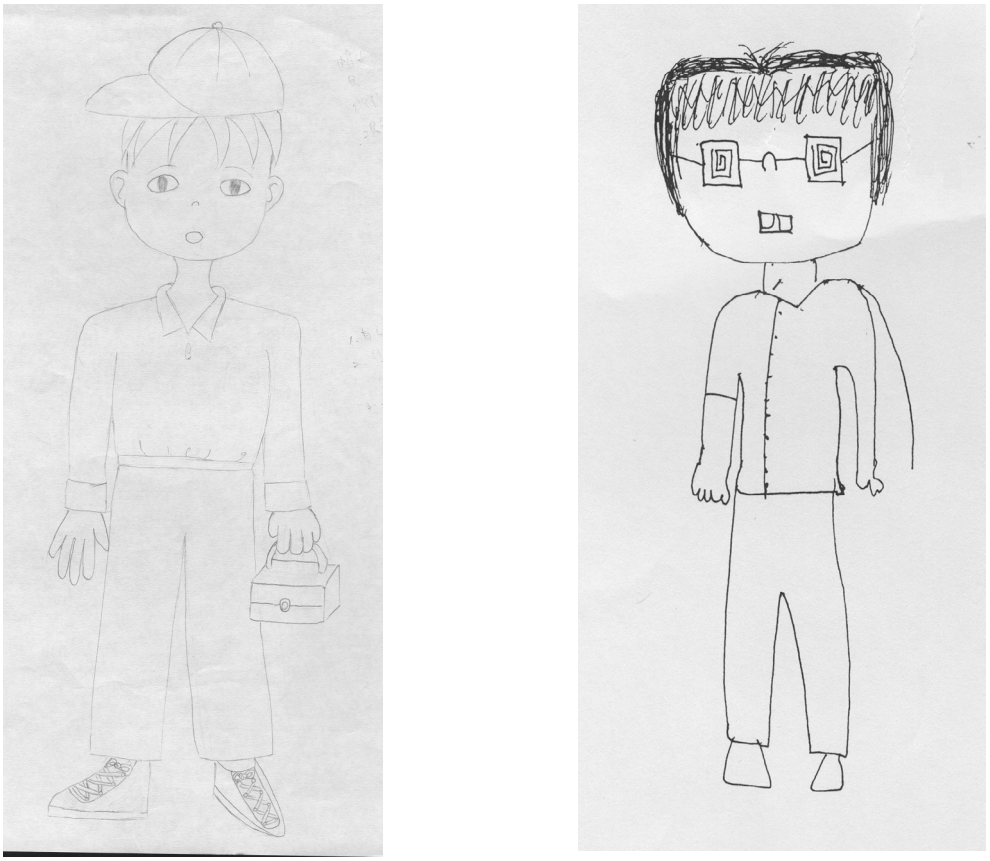

Figure 1: Drawings of a computer professional.

To counteract the validity problem in the DAST that has drawn criticism by researchers (Boylan et al., 1992; Losh et al., 2008), the research team supplemented the test with interviews to triangulate the pictorial data. A stimulated recall approach was adopted to determine each student's perception by examining the drawing together with the student and asking him or her to clarify questions or comments annotated by researchers earlier on the drawing. In addition, the students were asked to provide details and discuss the model they pictured (if any) when drawing the figure.

Immediately after the simulated recall, the research team conducted one-on-one interviews to ascertain the general impressions of computer professionals and computer jobs. The interviews were performed in a conversational style to determine student perceptions of others and themselves in relation to computers, and the students were asked about lifestyles, specific relationships, and activities in which they were involved (Barron, 2006). The interview questions included

- What distinguishing characteristics do computer professionals have?
- What type of working environment do computer professionals work in?
- What type of tasks do computer professionals do? How do you know?

- Would you like to choose a career in computers in the future? Why?

In addition, the research team cross-checked student gender and background to account for discrepancies in image perceptions. The data collected and transcribed were coded by segmenting the text into meaningful units and assigning code labels, such as gender, attitude, and personal characteristics, to each segment. By referencing constructs in prior studies (Chambers, 1983; She, 1998), the researcher refined the codes as necessary and then grouped similar codes into broader categories.

Results of Research

Perceptions of Computer Professionals

Perception of a computer professional's gender

The pictorial analysis indicated that male computer professionals were depicted more frequently than female computer professionals (Table 1). Half of the drawings by female students were female computer professionals; however, of the thirty-five drawings by male students, only three depicted female computer professionals. A chi-square test (χ^2 = 12.817, df = 1, $p < 0.001$) indicated that male students held significantly stronger gender stereotypes than female students regarding computer professionals. However, the interviews suggested that the majority of male students did not consider computer careers to be more suitable for men; they simply preferred drawing male figures to drawing female figures. Almost all students, boy and girls, asserted that people of either gender can become computer professionals.

Table 1. Gender of computer professionals in drawings.

Groups	Gender of depiction				Total	
	Male		Female			
	N	%	N	%	N	%
Place						
Urban	23	35.9	8	25.8	31	48.4
Rural	24	35.9	9	14.1	33	51.6
Gender of students						
Boys	32	50.0	3	4.7	35	54.7
Girls	15	23.4	14	21.9	29	45.3
Total	47	73.4	17	26.6	64	100

Perception of appearance

A high percentage of the student-drawn computer professionals appeared to be smiling and wearing glasses (Table 2). According to the interviews, the smile conveyed various meanings. Some students drew a smiling figure because of the priming effect; many other students sought to express computer professionals' affable personalities or satisfaction with their jobs.

The belief that computer professionals wear glasses, which is among the most common stereotypical characteristics on the images of computer users. Wearing glasses has two meanings: Glasses indicate an abundance of knowledge, whereas a negative image of near-sightedness was suggested in the interviews conducted in the current study. These positive and negative images were biased according to student backgrounds. A chi-square test suggested that a significant difference in depictions of scientists wearing glasses existed between place groups (χ^2=22.524, df=1, p< .001) and between gender groups (χ^2=34.035, df=1, p< .001). More male students depicted scientists wearing glasses than did female students. Similarly, a higher percentage of students from the urban group depicted scientists wearing glasses than did those from the rural group, possibly because the majority of male

students and urban students associated computer work with intensive computer operation. Thus, they envisioned the stereotypical poor eyesight of computer professionals caused by staring at computer screens for long hours.

Table 2. Computer professionals' appearance in children's drawings.

Appearance	Place				Gender				Total	
	Urban		Rural		Boys		Girls			
	N	%	N	%	N	%	N	%	N	%
Smiling	19	29.7	27	42.2	23	35.9	23	35.9	46	71.9
Wearing glasses	24	37.5	6	9.4	28	43.8	2	3.1	30	46.9
Carrying a toolbox	3	4.7	9	14.1	4	6.3	8	12.5	12	18.8
Wearing a hat	1	1.6	8	12.5	5	7.8	4	6.3	9	14.1
Wearing a tie	2	3.1	6	9.4	6	9.4	2	3.1	8	12.5
With beard	4	6.2	0	0	2	3.1	2	3.1	4	6.2
Carrying a computer	0	0	2	3.1	1	1.6	1	1.6	2	3.1
Cross-eyed	2	3.1	0	0	2	3.1	0	0	2	3.1
Wearing lab coat	1	1.6	0	0	1	1.6	0	0	1	1.6

Perception of personality traits

Computer professionals were most frequently depicted as mild tempered, knowledgeable, socially attractive, and vivacious in this study (Table 3). Most students during the interviews used positive terms to describe computer professionals; few students mentioned negative traits, such as unsociability, a bad temper, or an eccentric personality.

Table 3. Computer professionals' personality traits.

Traits	Place				Gender				Total	
	Urban		Rural		Boys		Girls			
	N	%	N	%	N	%	N	%	N	%
Mild temper	3	4.7	12	18.8	7	10.9	8	12.5	15	23.4
Knowledgeable	11	17.2	0	0	5	7.8	6	9.4	11	17.2
Socially attractive	1	1.6	7	10.9	4	6.3	4	6.3	8	12.5
Vivacious	2	3.1	5	7.8	4	6.3	3	4.7	7	10.9
Quiet	4	6.3	0	0	3	4.7	1	1.6	4	6.3
Patient	1	1.6	3	4.7	2	3.1	2	3.1	4	6.3
None (normal)	0	0	4	6.3	2	3.1	2	3.1	4	6.3
Enthusiastic	0	0	3	4.7	1	1.6	2	3.1	3	4.7
Unsociable	3	4.7	0	0	1	1.6	2	3.1	3	4.7
Devoted	3	4.7	0	0	2	3.1	1	1.6	3	4.7
Cute	2	3.1	0	0	0	0	2	3.1	2	3.1
Bad temper	0	0	2	3.1	1	1.6	1	1.6	2	3.1
Decisive	1	1.6	1	1.6	1	1.6	1	1.6	2	3.1
Creative	1	1.6	0	0	0	0	1	1.6	1	1.6
Queer-habit	1	1.6	0	0	1	1.6	0	0	1	1.6

The perceptions of personality traits held by male and female students did not differ. However, students from different cities held contradicting perceptions of the personality traits of computer professionals. A chi-square test indicated that students from the two cities significantly differed regarding three personality traits, namely a mild temper ($\chi^2 = 6.534$, df=1, $p < .05$), knowledgeability ($\chi^2 = 14.140$, df =1, $p < .001$), and socially attractiveness ($\chi^2 = 4.728$, df=1, $p < .05$). Further analysis of the interviews revealed that the contradictions in the images were due to variations in the perceptions of computer work. Students in the urban group used words such as "knowledgeable," "quiet," "mild tempered," "unsociable," and "devoted" to describe computer professionals; these traits are similar to those used to describe scientists in previous studies. Students in the rural group listed traits such as "mild tempered," "socially attractive," and "vivacious," which are traits frequently used to describe salespeople. Perceptions of computer work prompted the students to form distinct perceptions. The urban group of students considered the work of computer professionals to involve tasks in computer rooms that singularly focus on computers; the rural group considered computer work to be repairing and selling computers, which require communication with clients.

Perceptions of Work and Career Choice

Perception of computer work

Student impressions of computer professionals' work and work environment varied. They identified the work environments of computer professionals as computer companies, businesses, schools, homes, and shopping malls. The perceived job tasks were repairing computers, teaching computer skills, data entry, programming, selling computers, and information searching (Table 4). The top three job tasks identified by the rural group were repairing computers, data entry, and selling computers, whereas the top tasks identified by the urban group were teaching computer skills, computer programming, and searching for information.

Table 4. Content of computer professionals' work.

Tasks	Place				Gender				Total	
	Urban		Rural		Boys		Girls			
	N	%	N	%	N	%	N	%		
Repair computer	3	4.7	18	28.1	7	10.9	13	20.3	20	32.8
Teach computer	5	7.8	4	6.3	8	12.5	1	1.6	9	14.1
Data entry	2	3.1	6	9.4	6	9.4	2	3.1	8	12.5
Computer programming	4	6.3	3	4.7	7	10.9	0	0	7	10.9
Sell computers	0	0	6	9.4	4	6.3	2	3.1	6	9.4
Search information	3	4.7	3	4.7	4	6.3	2	3.1	6	9.4
Design web pages	1	1.6	2	3.1	1	1.6	2	3.1	3	4.7
Use software package	2	3.1	1	1.6	1	1.6	2	3.1	3	4.7
Design computer	2	3.1	0	0	2	3.1	0	0	2	3.1
Invent things or ideas	2	3.1	0	0	2	3.1	0	0	2	3.1
Design games	1	1.6	1	1.6	1	1.6	1	1.6	2	3.1
Design graphics	0	0	2	3.1	1	1.6	1	1.6	2	3.1
Develop software	2	3.1	0	0	2	3.1	0	0	2	3.1
Assemble computers	1	1.6	0	0	1	1.6	0	0	1	1.6
Design network	1	1.6	0	0	1	1.6	0	0	1	1.6
Write reports	1	1.6	0	0	0	0	1	1.6	1	1.6
Setup network	0	0	1	1.6	0	0	1	1.6	1	1.6
Find creative techniques	1	1.6	0	0	1	1.6	0	0	1	1.6
Install software	0	0	1	1.6	1	1.6	0	0	1	1.6

Overall, the urban group had a more diversified image of computer job tasks than did the rural group. The list included low-level computer tasks, such as data entry and information searching, and high-level computer tasks, such as computer design and software development. By contrast, the rural group tended to concentrate on low-level jobs, such as repairing computers, data entry, and selling computers. According to chi-square test results ($\chi^2 = 14.596$, df=1, $p<.001$), only repairing computers significantly differed between place groups. In other words, more students in the rural group associated repairing computers with computer professionals' work than did students in the urban group.

According to information revealed in the interviews, student knowledge of computer job tasks was obtained from the living environment. Therefore, urban students and rural students developed contrasting images regarding computer work because of differences in engagement in their life contexts. Taichung is a metropolitan city containing enterprises in various industries, such as banking, tourism, manufacturing, and IT. Students have access to learning opportunities through technological enterprises and the community. In addition, they are exposed to high-level computer professionals through activities or relationships. By contrast, Chiayi is a less industrialized city, and mainly contains agricultural and retail enterprises. Many rural students recalled personal experiences with computer salespeople in shopping malls, engineers who repaired computers, technicians who installed in-house networks, and computer teachers at school. Following are some expressions about images of computer experts given by students during interviews:

> "My family and I met computer salespeople several times in the shopping mall. They could explain the detailed features of the computers" (rural group student)
>
> "When my house installed network, a man set up the wire and then tested the connection with a computer. He worked hard and sweated a lot." (rural group student)
>
> "My computer teacher is familiar with several kinds of software. He will teach us how to use them." (rural group student)
>
> "A computer expert is capable of repairing computers. Just like workers at the computer store." (rural group student)
>
> "My cousin is working at the information department of a company. He told me about what he is doing at work." (urban group student)
>
> "A friend of my family is doing computer-related work. My parents sometimes talk about his job and salary." (urban group student)
>
> "I do not know any computer expert. Just some impression from TV or films. They are always typing something in front of a computer, maybe entering data or writing programs." (urban group student)

Student career preferences

When the students were asked about their willingness to choose a computer-related profession, 28% answered positively, 52% answered negatively, and 20% provided a neutral opinion or no opinion (Table 5). The interviews implied that the students responded negatively because they already considered more favourable career choices. Many students had decided to become medical doctors, nurses, artists, teachers, or singers. Influenced by their families and relatives, students considered these professions to be more interesting or prestigious than computer professions. In addition, stereotypes exerted negative effects. For example, many students believed that excessive computer use results in poor eyesight as well as social isolation, and therefore decided to avoid jobs that are harmful to their health.

Although statistical analysis indicated no difference in computer career choice between place groups, the students held contrasting perceptions of computer work. Of the students in the urban group, 41% held negative opinions of computer careers, whereas more than 58% of the students in the rural group held negative opinions. Rural students associated computer careers with difficulty and hardship, low wages, and high pressure. Consequently,

these stereotypes about computer work negatively influenced student impressions of the profession.

Table 5. Students' attitudes toward computer careers.

Attitude	Place				Gender				Total	
	Urban		Rural		Boys		Girls			
	N	%	N	%	N	%	N	%		
Positive	8	12.5	10	15.6	13	20.3	5	7.8	18	28
Negative	14	21.9	20	31.3	15	23.4	19	29.7	34	53
Neutral	8	12.5	2	3.1	5	7.8	5	7.8	10	16
No opinion	1	1.6	1	1.6	1	1.6	1	1.6	2	3
Total	31	48.4	33	51.6	34	53.1	30	46.9	64	100

Regarding gender difference, a chi-square test indicated differences between boys and girls in the attitudes toward computer careers ($\chi^2 = 3.741$, df=1, $p < .05$). Female students tended to hold negative attitudes toward computer careers because they "prefer talking to people," think that "English is difficult" and the "salary is not good," believe that computers "harm eyesight," and do not want to be "too busy at work."

Discussion

Living Environments Influence Understanding of Computer Profession

Although some students drew computer professionals that were based on their computer teachers or characters in comic books or on television, a majority of the students mentioned that they drew the figures based on their imaginations; thus, the computer professionals were drawn according to student perceptions of computer job tasks and work environments. Without much familiarity with computer professionals, students did not have a clear image of computer professionals, except for those seen in shopping malls or at school. Unlike previous studies that suggested that the image of scientists and engineers is influenced by role models and the media, this study indicated that students observed people engaged in computer tasks in their surroundings and projected them as images of computer professionals. This observation corresponds with that of Bandura (1989), who indicated that people who are present and observable in children's lives "serve as indispensable sources of knowledge that contribute to what and how children think about different matters" (p. 13).

In this research, contrasting images of computer professionals and their job tasks were observed. The discrepancies between images can be attributed to differences in the students' living experience. Students from an urban area tended to describe computer professionals as scientists by using terms and phrases such as "knowledgeable," "wearing glasses," "quiet," whereas students from a rural area tended to describe computer professionals as people who sell or repair computers by using terms such as "good personality," "vivacious," "smiling," and "socially attractive." These images were derived from the students' living environment. Most students in the rural area described computer professionals as computer salespeople in shopping malls, network installation technicians, and computer teachers. Those were the computer-related people that students had encountered in their daily life. By contrast, the urban students had relatives, family, or family friends working at technology-related companies or information departments. And the personal witness or indirect contact became the sources of computer profession information.

Furthermore, stereotypical images or insufficient comprehension of computer profession influenced students' career choice. Instead of imagining higher prestige and salaries, rural students considered the computer profession to be a substandard career. The image envisioned by rural students is associated with hardship, low wages, and sales pressure. Although urban students associated the job with knowledgeability and devotedness, many believed that excessive computer use results in poor eyesight and social isolation. They did not select this unhealthy job as their top career choice.

Some students from the urban group became aware of computer work tasks through conversations with

relatives or family friends who were engaged in computer professions. Because of the limited number of computer-related businesses in agricultural areas, rural students seldom interact with professional computer workers and, therefore, formed an image of computer jobs mainly by observing computer teachers, computer salespeople, and computer shop workers.

An ideal role model is a person who is able to establish personal connections, and previous research has confirmed the effectiveness of role models in encouraging young students to pursue scientific careers (Buck et al., 2008). Because student perceptions of scientific work were shaped by personal experience with computer professionals in this study, the information discrepancy possibly resulted in a difference in perception between the groups with dissimilar backgrounds. Students who receive an inadequate amount of information are insufficiently familiar with computer workers with high skills and ranks. Instead, they base their impressions of computer professionals on salespeople and computer repairpersons that they encounter.

Gender Stereotypical Images on Computer Career Exist

The results indicated that girls and boys considered computer professionals to be both male and female. Although no gender difference was observed in the students' images of computer professionals and their work, a gender difference in attitudes toward computer careers existed. The interviews revealed that gender stereotypical images influenced student perceptions of the work of computer professionals. Despite feeling that girls can become computer professionals, female students preferred to pursue more gender-suitable professions, such as teaching, nursing, and artists, rather than enter the computer field. In addition to stereotypes, family attitudes also influenced young students' career preference. Lacking understanding about computer job tasks, parents adopted and imposed traditional views on choosing careers based on gender suitability, salary, prestige, and laboriousness.

A prior study on female college students' perceptions on computer profession in Taiwan confirmed the prevalent impression that computer profession was male dominated (Fan & Li, 2005). The comparative results suggested that students envisioned no gender stereotypes on computer profession during elementary school, but became fully aware of gender stereotypes before they enrolled in college, implying that gender stereotypes or awareness gradually develop during high school. To shape student views on computer profession, particularly in remote areas, activities of recruitment or industry visit should include students and their older family members. Changing parents' traditional views on profession will enhance the effectiveness of recruitment.

Implications of Educational Activities

In this research, English language ability, instead of mathematics and science, was the competence according to which students judged themselves. The elementary English learners frequently associated computer tasks with difficulty in using English vocabulary in computer programming or webpage design. In fact, the IT industry is increasing the diversity of talent in order to face the rapidly emerging challenges. Students' self-perception could limit their career choices. Thus, barriers to participation in IT fields are associated with a lack of subject advice from teachers or experts. Computer teachers and professionals can share their passion and expertise with high school students, particularly girls, possibly causing students to change their perceptions of computer professions.

The results indicated that less than half of the students expressed interest in pursuing a computer profession. The results were similar to those of previous studies that suggested that students do not have a well-rounded appreciation of science and the work that scientists undertake. To enhance students' image of computer professionals, they should be exposed to computer work particularly in authentic environment. As Aharony (2006) reported, college students rate professions more highly when they positively perceived the professional image. Therefore, relevant educational activities should be encouraged to instil students with a broader and more accurate perception of professions. For example, schools could hold an IT career camp as an early intervention strategy to change student perceptions of IT work and their career preference.

Conclusions

In Taiwan and other developed countries, the digital divide is a topic of concern. Currently, access to IT entails more than merely providing computers and Internet connections; rather, access to IT involves a complex array of resources, such as education, community, and relationships that influence life decisions. Even though every

school in remote area has access to IT, contextual understanding and access to IT professionals are imbalanced. Because of the discrepancy in information source diversity and quality, young students from different social classes or neighbourhood perceive and develop dissimilar images of computer professionals that eventually influence career and life choices.

Consistent with numerous research findings indicating that a lack of knowledge related to scientific work hinders students from pursuing science fields, this study confirmed the influence of student perceptions of computer work on their career preferences. Moreover, young students from urban and rural areas envisioned various images of computer job tasks, representing the disparity in their learning opportunities. The "learning ecologies" framework implies that learning opportunities are sets of contexts comprising activities, material resources, and relationships in physical or virtual spaces. The roots of an information gap or digital divide are embedded in social and developmental differences between groups. Excluded from social contexts in which IT is typically learned and used, the minority youth are rarely tempted to pursue highly technological careers because they lack experience and encouragement.

To face the recruitment challenges, educators should act to change the stereotypes envisioned by students regarding computer careers. In addition to surface-level changes, educators should engage with students and their families in IT-related activities that can facilitate a deeper understanding of computer careers. Learning opportunities, including speeches by computer professionals about their work, field trips to computer professionals' workplaces, collaborative projects, and IT camps, can enhance the attraction of students, particularly female and minority students, to the profession.

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