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Information Technology Gifted Program under the National Curriculum Reform of Basic Education: A Case Study on a Senior High-School in Shanghai, China

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Abstract

As the definition of 'giftedness' differs by country, policy set to support gifted education differs accordingly. The objective of this study is to investigate the outcomes of the IT Gifted Program offered by Yi Chuan Senior High School in Shanghai. The participants are 24 students who were or had been enrolled in this program. Data was collected through semi-structured interviews and documents related to the program. The IT Gifted Program is found to boost participants' confidence in their abilities in the information technology field. Furthermore, most of the gifted students reported great learning improvements in all academic areas, showed increased confidence in general and were more engaged in both collaborative learning and independent study. Most importantly, positive outcomes in terms of successful admission to higher education institutions are evidenced.

Keywords: gifted program, gifted student, information technology, evaluation, social skills.

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Introduction

The interest in gifted students is increasing. There are many associations for gifted children, such as the National Association for Gifted Children (NAGC), the Davidson Institute for Talent Development, The National Society for the Gifted & Talented (NSGT), and The National Research Center on the Gifted and Talented. However, despite the rising number of such associations, this field is under-researched. The history of gifted and talented education dates back thousands of years. In Ancient Greece, Plato advocated specialized education for intellectually gifted young men and women. During the Renaissance period, children who exhibited creative talents in art, architecture, and literature were supported by government as well as private patronage (Colangelo & Davis, 1997). In the modern era, William Torrey Harris was the first to initiate a systematic effort to educate gifted students in public schools in the United States. In 1916, Lewis Terman, the gifted education movement "father", published the Stanford-Binet, which changed intelligence testing and American education at large (National Association for Gifted Children, 2018a). However, gifted education caught the attention of governments and scholars worldwide after World War II, especially after the United States federal government passed the National Defense Education Act in 1958, which was the first large-scale government effort in gifted education globally. Due to the movement in the United States, Britain witnessed a rise in research on gifted children and social developmental initiatives beginning in the 1960s (Lindsay, 2002). Countries such as Australia, India, Singapore, and China also implemented similar programs.

In China, the gifted education programs originate in the first special class for gifted teenagers at the University of Science and Technology of China founded in 1978. Twelve universities, including Peking University, Tsinghua University, Fudan University, and Zhejiang University founded their own special classes for gifted teenagers in 1985 (Ye, 2014). Compared to the increasing number of gifted programs at universities during the following fifteen years, less attention was paid to the theory and practice of gifted programs in elementary and secondary education, until the National Curriculum Reform of Basic Education was implemented in 2001. In 2001, the Minister of Education (MOE) of China initiated the National Curriculum Reform of Basic Education, which was established to teach students according to their aptitudes, develop their individual characters, and cultivate unique interests (Zhong, 2009). The reform encouraged experimental programs of gifted and talented education in elementary and secondary schools. Subsequently, a variety of gifted programs for talented students in fine arts, music, sports, mathematics, and information technology (IT) were designed and put into practice. The rapid developments in science and technology have had a profound influence globally since the 1980s, especially the tremendous innovations in information technology in the so-called Information Age (Castells, 1999), which was reflected

in school education. Thus, a lot of emphasis has been placed on cultivating the abilities of IT gifted students by engaging them in advanced IT education programs.

It is clear that much is known about gifted students, but considerably less research exists on the actual impact of their participation in gifted programs. (Shore & Delcourt, 1996) and (Robinson & Clinkenbeard, 1998). This study examines IT education for gifted students at Yichuan Senior High School in Shanghai, China. The Marland Report proposes that gifted programs be evaluated, and scholars have emphasized evaluation as critical to gifted programs' success (Tomlinson, Bland, & Moon, 1993), to ensure that programs carry out planned activities effectively and achieve their objectives (Callahan, Moon, & Oh, 2017). This paper evaluates the effectiveness of the IT gifted program at Yichuan High School through interviews with current and former student participants in the program as well as its teachers. Based on their feedback, suggestions on how to effectively organize and structure an IT program curriculum for gifted students are made.

Literature Review

Defining "Giftedness" and "Gifted Education"

There is no generally accepted definition of giftedness. The concept associated with the term is often also referred to as "talent" or "abilities." Originally, IQ scores and academic achievement were emphasized in identifying gifted students. Terman (1926) noted that a student in the "the top 1% level in general intellectual ability, as measured by the Stanford-Binet intelligence scale or a comparable instrument" could be viewed as "gifted." In 1972, the Marland Report made the first formal definition that encouraged schools to define giftedness broadly. Along with academic and intellectual talent, the definition included leadership ability, talent in visual and performing arts, outstanding creative or productive thinking, and highly developed psychomotor abilities (National Association for Gifted Children, 2018a). Renzulli (1978) proposed three clusters of giftedness - superior general abilities, high levels of task commitment, and creativity and application ability - that cover most aspects of intelligence. Gifted and talented students are indeed a diverse group of individuals with outstanding abilities in one or more domains (Reis & Renzulli, 2009). The National Association for Gifted Children (2011) suggested redefining giftedness as follows: "Gifted individuals are those who demonstrate outstanding levels of aptitude (defined as an exceptional ability to reason and learn) or competence (documented performance or achievement in top 10% or rarer) in one or more domains. Domains include any structured area of activity with its own symbol system (e.g., mathematics, music, language) and/or set of sensorimotor skills (e.g., painting, dance, sports)". The NAGC also emphasized that the development of an ability or talent is a lifelong process, and when individuals' achievement and high levels of motivation in a domain become

the primary characteristics of their giftedness, various factors can either enhance or inhibit the development and expression of such abilities (National Association for Gifted Children, 2011). "Giftedness" could thus be summarize as high abilities in a specific field, but how to identify gifted individuals varies across countries.

What percentage of people count as gifted also vary. According to Robinson (1990) gifted person are a top 1-3% percent; according to Brody and Stanley (2005) the top 3%; according to Freeman (1999) the top 5-10%; according to Gagne (2004) the top 10%; and according to Renzulli (2005) gifted person are 15-20%. Definitions of giftedness concern high potential that can be cultivated through support or investment, and the scope of giftedness has been expanded over the years, with attempts to avoid the use of individual IQ scores in the definition of giftedness and talent (Chan, 2000). Moreover, characteristics such as creativity and motivation have been included in its definition (Sousa, 2002). Although "ability" has been emphasized in most definitions (NAGC, 2011), scholars find this insufficient to describe the idea of giftedness. Renzulli proposed that persons who "are capable of developing an interaction among the three clusters require a wide variety of educational opportunities and services that are not ordinarily provided through regular instructional programs" (Renzulli & Reis, 1986). Although they may emphasize different aspects of giftedness, most definitions refer to highly capable children with exceptional abilities (Gallagher, 1994; Chan, 2000; Gagne, 2004; Subotnik et.al, 2011). High performing children are those who have demonstrated high achievement and potential in general intellectual abilities, specific academic fields such as language arts, mathematics, or science, creative or productive thinking, leadership ability, visual and performing arts, or psychomotor abilities (Gallagher, 1994). In China, giftedness has been described as "God's bestowal upon man (Shi and Cha, 2000)", with more focus on special inborn abilities. Until 1978, researcher in China started using the term supernormal to express giftedness, reflecting the idea that supernormal children are superior to "normal" children. This term avoids differentiating between nature and nurture, inborn and environment factors, and instead evaluates children by their performance through statistical measures. Supernormal children can be identified by IQ score, academic performance, creativity or any other talent.

We are still far away from a consensus on how to the best identify the gifted, but global definitions of giftedness can be summarized in four dimensions (Heuser, Wang, & Shahid, 2017). The first-dimension concerns definitions of giftedness as either cognitive achievement or/and aptitude or excellence in both academic and nonacademic areas. In United Kingdom, Korea, Switzerland, Germany Taiwan, and Hongkong giftedness is conceptualized as exceptional acumen in multiple academic and non-academic areas, such as sports, music, arts, and soft skills (Casey & Koshy, 2013; Mueller-Oppliger, 2014). The second-dimension concerns giftedness as aptitude or as achievement. Systems that prioritize intellectual excellence as determinative of exceptional talent generally view giftedness as

either a high intelligence quotient (aptitude) or as high performance on criterion based, curriculum-related standardized tests (achievement). For instance, in Singapore, an achievement-oriented definition is used, as only top achievers on curriculum-based standardized exams are eligible to be identified as gifted. In Beijing, Taiwan, and Hongkong, the identification of students of cognitive excellence relies predominantly on IQ tests (Ibata-Arens, 2012), defining giftedness as aptitude. The third-dimension concerns the question of nature versus nurture. While some believe that people are born gifted, a more common belief is that giftedness is a result of an individual's predispositions as well as environmental factors conductive to developing the innate ability. In Germany, giftedness is defined as an individual's potential for outstanding achievement, and non-cognitive personality characteristics and environmental factors are both considered important in contributing to achievement (Fischer & Müller, 2014) The fourth-dimension concerns giftedness as associated with individualism versus giftedness as associated with collectivism. For instance, the Maori populations in New Zealand value the collective or belonging to the group as integral to intelligence that an individual's acting out of the ordinary may not be consonant with their understandings of giftedness. These four dimensions do not cover all interpretations or understandings of giftedness globally, but provide a useful perspective when concentrating on a local case.

Gifted education and gifted programs

Different perspectives on giftedness are reflected in forms of gifted education. Gifted education must be tailored to the learning needs of individual students, especially those gifted in specialized subjects, which requires teachers to match students' personal characteristics with their teaching methods and materials (Smith & Renzulli, 1984). Teachers must guide students toward recognizing the subject's real value, meet or support various interests, and enhance self-confidence (Subotnik, 2009). Thus, the goal of gifted education is to capitalize on existing interests, promote new interests, and develop research skills and thinking processes. The different gifted educational program models have been developed, based on how giftedness conceptualized, to support students' development and improve their abilities. Practices include general education self-contained classrooms, pull-out resource models, cluster groups, specialized schools, and special classes (Barnett & Durden, 1993; Feldhusen, 1992; Flack & Friedberg, 1997; Miserandino, Subotnik, & Ou, 1995; VanTassel-Baska, 2012).

Gifted education has been conducted differently across countries. The majorities of gifted education literature describes correlations of gifted education and emphasize theory. Gifted education research can guide policy and practice (Plucker & Callahan, 2014). In the United Kingdom, gifted education is guided by national gifted education policies. The policies encourage schools to consider the variety of gifts and talents demonstrated by pupils, including academic, sport, leadership,

artistic performance, or applied skills. Prior to 2011, the policy stipulated that 5% to 10% of each cohort be placed on a gifted and talented register at the school; therefore, educators in the UK predominantly used national or school test result to identify gifted students (Casey & Koshy, 2013). Switzerland has no national strategy on gifted education, but all cities have developed their own policies for identifying and cultivating giftedness, and request individual school to indicate its gifted education policy (Mueller-Oppliger, 2014). In Korea, gifted education is operated by National Research Center for Gifted and Talented Education under the Ministry of Science and Technology, and the Ministry of Education and includes teacher recommendation, aptitude tests, tests of creative problem-solving abilities in math and science, interviews, and scientific experiments of the school population Four % of students in Korea are being served under the gifted education system (Han, 2007). Other countries do not support gifted education to the same extent, as it is considered to threaten equality in education.

Gifted programs in high school take a variety of forms. There are many dimensions including the identification process, the service delivery model, and standards and curriculum targeting gifted students. Effectiveness studies have generally been program-specific or have examined predicted outcomes, such as changes in self-concept, achievement, or future accomplishments. Examining the impact of gifted programs qualitatively and holistically requires exploring several areas of research. Research on gifted program includes longitudinal studies and studies on the effects of particular program models. Longitudinal studies are relevant to understanding the complexity and multiplicity of the outcomes that can result from students' experiences. Glimpses of relevant research in those areas are reported here to provide greater insight into the experiences shared in the students' reports. The longitudinal studies have enabled the field of gifted education to examine factors that contributed to individuals' eminence, talent, or giftedness. Such studies focus on understanding the factors that lead to exceptional levels of achievement or talent development, such as White and Renzulli's (1978) study on children with high IQ. With children who had participated in an enrichment program in New York City as research sample, the research found that respondents attributed an interest in learning for life, pleasure in independent work, and joy in interacting with similarly high-ability students to their program participation.

Another relevant study is that by Moon, Feldhusen, and Dillon (1994), who found that the Purdue Three-Stage Model had a positive impact on most participating students, who had improved their thinking and problem-solving skills. Renzulli and Reis (1994) reported that the Schoolwide enrichment model created by Joseph Renzulli may improve aspects of high-ability students' school experience, including classroom climate, instructional processes, students' self-concept, attitudes toward learning and postsecondary plan. In a study by Davalos and Haensly (1997) that investigated the perceived value of an Independent Study course for gifted high school students, 47.5% of students reported an improvement in students' self-esteem and 23.5% believed that the program had

made a significant contribution to their life. The researchers concluded that gifted programs had long-lasting effects and were an economically beneficial option for gifted student. These studies show that research on gifted education and gifted programs can reflect students' perspectives and provide windows into intangible, unintended, or immeasurable outcomes of gifted education, and gifted programs service.

Methodogy

A case study as research method is difference from ethnography, phenomenology, grounded theory, and generic qualitative research methods. Case study research can be defined as focusing on holistic descriptions and explanations, and being particularistic, descriptive, and heuristic (Merriam, 1998). In this study, it was useful to examine contemporary events from a stance where the relevant behaviors could not be manipulated, since the program examined had already been conducted. The case study method focuses on how and why some phenomena work, seeking an extensive and in-depth description of a social phenomenon (Yin, 2009). By focusing on a single case, this study gives an in-depth account of the learning experiences of gifted and talented students in a gifted program to determine the best method for organizing and teaching such programs in general. Action research was employed in this study. Action research is a participatory, democratic research process that seeks to combine "action and reflection, theory and practice, in participation with others, in the pursuit of practical solutions to issues of pressing concern" (Brydon-Miller, Greenwood, & Maguire, 2003). This approach is especially suitable for research related to teaching practice (Kemmis & McTaggart, 2005) and this research includes a considerable amount of teaching practice as well as reflection on the IT gifted program. Non-participatory observation, semi-structured interviews, and document revision were used for data collection (Erwin & Worrell, 2012).

Study Context and Research Design

In 2001, the Ministry of Education in China issued an important reform document titled "Outline of Basic Education Curriculum Reform," aimed at enhancing national educational quality and expanding provincial government autonomy in educational administration. The curriculum reform focused on six targets: paying more attention to students' interests, attitudes, experiences, problem-solving abilities, research, and cooperative learning. The reform aimed to construct a new three-level education structure of national, provincial, and school-based curricula (Ministry of Education [MOE] 2018).

In September 2004, Yichuan High School tried to reconstruct its curriculum and instructional system to adapt to the requests of the National Curriculum Reform

of Basic Education. In light of an increasing number of students with outstanding abilities in IT class who hoped to improve themselves further, all seven IT teachers at the school decided to form a teaching and research group to design a special project to meet these students' learning needs. An IT program for gifted students named "Experimental Classes" was put into practice the next month. The group began by confirming the goal of the gifted program. Following much discussion, they arrived at *fostering the development of students with high abilities in IT* and *creating opportunities for gifted students to apply what they have learned* as the program's goals.

Most gifted IT students at Yichuan High School are identified at the beginning of their high school careers. When students enter high school, they are required to fill out an interest inventory that uses a rating scale. This tool was developed to identify gifted students and provide information on many aspects of students' personalities, such as motivation and IT achievements (Worrell & Schaefer, 2004). Classes are then divided into different special groups where gifted IT students can choose subjects according to their interests. When a gifted student shows interest in a particular IT topic, they are allowed to pursue their own interests under their teacher's guidance. Students who have above-average abilities in IT can also be placed in the IT gifted program on their teacher's recommendation, or through self-nomination if they show strong logical thinking ability in other science subjects. Thus, teachers pay attention to students who are already doing well academically but also to those students who have the potential to become good at the subject. The third way to identify gifted IT students is from the entrance examination for senior high school. Although the standardized testing is not a certain indicator, it is understood that students who do well in major subjects (i.e., Chinese, math, and English) may have more time and energy to study IT.

The selected students were grouped into the Experimental Class, which aimed at equipping students of high potential with IT skills. At this stage, the curriculum focuses on basic IT knowledge such as animation, creating webpages, and Pascal program design. Teachers also design appropriate curricula to meet students' individual needs and engage students in self-directed learning. At the next stage, most students who started with the mindset of "having a try" may not have kept up with the pace of teaching. Thus, a knock-out system was introduced. The "Experimental Class" excluded those who had negative attitudes toward the curriculum, who did not perform to their potential, and who did not dedicate sufficient time to their IT learning. During the middle stage, the teachers concentrated on training in software operation and provided several opportunities for the students to participate in various competitions. In their final year of high school, the number of students attending the IT gifted program was reduced, due to attention required for college entrance examinations. Accordingly, the teachers adjusted the pure training plan to a goal-oriented curriculum connected to the entrance examinations. To get extra credit during the final examination, the remaining gifted IT students participated in more competitions. For in-depth

learning, students had to learn to design their own study plan while ensuring that it was aligned with their goals and objectives. Regardless of which stage the students were at, helping these youngsters tap into their potential and achieve better learning outcomes was the teachers' responsibility. The teachers had to be continually attentive to gaps between student learning experiences and their instructional methods (Smith & Renzulli, 1984) to connect learning experiences to the curriculum and cultivate greater student potential. The teaching combined individual instruction and extracurricular tutorials, and the students were encouraged to engage in collaborative learning, that is, they were encouraged to discuss the topics with their group, share the benefits of the outcome, make sure every member understood the real meaning of the task, and work together to achieve the same goal (Johnson & Johnson, 1999).

Sample and Data Collection

This study involved 24 students, 14 male and 10 females, with four of them being involved in the program for three years, two of them for two and a half years, four of them for one and a half years, and 14 for one year. Four graduates, who had a good understanding of the project, were able to provide valuable suggestions, through which the teachers were able to understand the real efficacy of gifted education; they had undergone significant changes in their attitudes and learning preferences during the gifted IT program. The remaining 20 participants were students who were still involved in the gifted program, including programming contests, IT application development, CAXA physical design, and the Intelligent Robot Project. Numbers were assigned to each participant in order to prevent their identities being revealed. Numbers 001 to 004 were students who have graduated, and numbers 005 to 024 were current students. Pseudonyms were also used for information technology teachers (A1-A7) who were interviewed. Oral consent was obtained from all participants and recorded on tape while conducting the interviews.

The interview process was divided into three phases with three groups of students based on training stages for different perspectives on the gifted program. In addition, this was the easiest way to recruit participants, as the students had several other commitments. The three interview sessions were conducted in August 2010, March and April 2011, and September 2011. The first interviews focused on painting a clear picture of the graduates' viewpoints and fresh memories of the gifted program they participated in during high school. The interview venue was the school's teachers' office, which was quiet and familiar to the graduates. In the next two interviews phases, the interviews took place in computer classrooms after school.

The interviews were semi-structured, with the protocol including questions on how the students feel about the selection criteria of the gifted program, how students feel about the help they receive from the program, how students perceive

their improvement in the specific IT areas, what kind of problems they had to face during the program, and their suggestions for the program. The teacher interview questions focused on the perception of gifted selection in general, students' performances in the Experimental Class, and the outcomes of gifted classes. Appointments were made through e-mail or phone messages to schedule the interviews. The 45-minute-interviews were conducted in Chinese and tape recorded. They were then transcribed into English to facilitate further data analysis.

Most information about the teachers, including teaching methods, teaching reflection, and the selection and reorganization of teaching materials was collected from group members' teaching plans, the records of monthly meetings, and reports presented by them during the symposiums organized at the end of each term. Regular or irregular communications and interactions among teachers also transmitted valuable messages.

Results

The Information Technology Gifted Program at Yichuan Senior High School was found to have helped students recognize their own strengths and gain a better understanding of the subject. It had also improved students' problem-solving skills, motivation and positive attitudes toward learning. Moreover, it had helped teachers recognize differences among students.

Recognizing own strengths

Participating in the gifted program helped students identify their own strengths and abilities in learning. They became aware of their abilities through the selection and cultivation process of the program, and through communication with their teachers. First, awareness of their advantage over other students in IT served as motivation for them to keep pace with the contents taught in the gifted program classes. The students are required to obtain relevant skills and abilities even during the selection stage. Two students said that logical thinking and mathematical abilities helped them enroll in the gifted program, as they were asked what they thought their strengths were in the operation of a computer (014, 015). Four students said that they had gained computer experience before entering senior high school, which certainly helped them to become members of the program (022, 024, 001, 002). One second-year student (014) who made much progress afterwards commented as follows:

> *"My strong points are programming, information searching, and typing. I also have experience with Dreamweaver, ASP, Flash, MYSQL, and Photoshop. Most importantly, I am interested in computers and I always try my best to solve the problems at hand" (014).*

This comment demonstrates students confidence in their abilities that qualified them for the program. Comments such as "I have a solid foundation in painting that is based on creativity" (001), and "I think of the procedure of photograph processing as a joy instead of a burden" (002) reflect the participants' readiness to join the gifted program.

Regarding discovery and utilization of their abilities, most students expressed positive feelings and a desire to participate actively in their classes and communicate well with their teachers. Most of the participants suggested that it is essential to communicate with the teacher in or after class. The following graduate's (001) comment illustrates this point well:

> *"I demonstrate my great passion for information technology by always asking questions in class. Also, I complete my assignments carefully and seize any opportunity to interact with teachers after class. It is necessary to make efforts to build trust between students and teachers. Teachers in this school respect each student's learning interests with open minds; furthermore, they are willing to invest much time in teaching students" (001).*

The students also said that it was the teachers who enabled most of their knowledge acquisition and skill development in IT. Generally, teachers helped them develop their abilities in logical thinking, competition, and interest searching, as students commented: "correct logical thinking makes it easy for me to deal with specific issues in programming" (024); "thanks to competitions in computer class, I complete daily computer exercises smoothly and these achievements also relate to my math learning" (014); and "these advantages support me in persisting in what I really like" (001). In the process of selecting students and teaching classes, the teachers emerged as those who helped the students to understand their own advantages and abilities better.

Developing a Deeper Understanding of the Subject

After entering the Experimental Class, the students' understanding of computers deepened. According to the students, a computer represents not only the fruit of the development of information technology, but a modernizing innovation. Nowadays, computers are found in most households, and they have become the carriers of knowledge; in this way, they represent a new learning platform. The IT gifted program is thus a useful tool to help students learn more about the attributes of computers and use the Internet to enhance their learning. This viewpoint was expressed by the students during the interviews. The following student's (001) answer to the question "why do you think a computer is a great study instrument" is a good example:

"Many years ago, I got my own computer, which was just a game machine for me. Later, I used it to listen to music or watch movies, yet I still saw the computer as an entertainment tool. When I learned about the Internet and different kinds of software, I realized that it was not a simple machine; however, I still did not understand the deep meaning of computer use. I did not know how limited my understanding of computers was until I participated in the gifted program. The computer teaches me to learn by myself and to explore the unknown. It is really an amazing invention in the history of mankind" (001).

Others said that computers opened their minds and enriched their knowledge. Student 024 commented as follows:

"Before middle school, I thought that computers were only used to make tables and forms, which seemed boring to me. After entering high school […] I started to understand that computers are not as simple as I used to imagine. A lot of simple designs require complicated coding and computer science is a complicated subject" (024).

Most of the students thought that they do not get much knowledge about computer science; instead, the capabilities they obtained thorough information technology learning were bigger rewards. Students could learn something new outside the classroom without teachers, create new computer programs, and so on. Improving student understanding of computers can be considered a strength of the gifted program, which also assisted students to better understand information technology in general, improve their learning motivation, and to deepen their learning experience. Thus, through participation in the IT gifted program, the students could better connect computers with their applications in a wider scope.

Improving students' learning motivation, attitudes, and problem-solving skills

Students' interest, motivation, attitude, and confidence in learning were all improved by the IT gifted program. The program and its activities displayed something new and amazing to the students, who were guided in self-directed learning, which created a positive learning environment. Student comments that demonstrate this point include the following: "participation in the gifted program enables me to think more about the relationship between striving and harvest and to see learning as fun" (001); "the more knowledge I master enhances my motivation and confidence and makes me take learning much more seriously" (002); and "basic understanding generates more interest in a topic, which enhances motivation and improves the skills that wins others' recognition and strengthens confidence" (004). They put what they have learned in the IT gifted program into a problem-solving model to apply to other subjects or even life events. The following student quote demonstrates this point:

"I started to draw inferences about other subjects from the IT curriculum. When facing problems, I would encourage myself to work hard for a satisfactory achievement. I need to develop interest in other cases so that I can get rid of daily boredom. The IT gifted program has given me hope and has encouraged me to think about the meaning of life" (001).

Most of the students in the IT gifted program said that it changed them in a significant way. The students learned to seek advice from teachers and peers rather than being passive recipients of information. There is no element more influential on performance than motivation, which leads students to succeed in gifted programs. The most important thing is that they formed the habit of venturing into uncharted territory and did their best to update their skills. The students may have acquired some IT knowledge from computer games; however, the gifted program, to some extent, changed their attitude toward IT and gave them a sense of accomplishment.

Changes in interest, motivation, attitude, and confidence affected the students' general academic confidence. Most students said that after participating in the gifted program, they felt more confident in themselves and their academic abilities. Comments from students 014 and 020 demonstrate this point:

"In my leisure time, I program on my own. Sometimes I make a physical model that simulates the real world by combining physics and IT. It helps me to build up my self-confidence and my interest in going further in this field" (014).

"The gifted program enhanced my study life and reduced my feeling of boredom at school. I started to believe in my competence and viewed learning more positively; thus, my overall academic performance improved. It also enhanced my confidence in other subject areas. I believe I can make progress if I work hard" (020).

Most of the students believed that joining the Experiment Class helped them to do better across all academic subject areas. Student 023 said that mathematics and physics knowledge is applied frequently during the gifted training, so he is becoming more confident in his ability to succeed in these specific subjects. Student 004 was aware of doing much better than his peers in main subjects and in less time. This showed him the positive impact of the gifted program on academic learning in general.

The inquiry-based learning and collaborative learning that was emphasized in the program enhanced students' critical thinking abilities. Keen interest enabled the students to overcome difficulties independently and inspired them to work harder. Student 001 commented as follows:

"We used to like to write down what teachers say instead of asking questions. When we were asked to participate in a competition, we had to take the initiative to consult teachers or classmates. In that way, we formed good self-study habits" (001).

Student (018)'s comment reinforced this point:

"I began to take homework seriously. After finishing the work, I would discuss it with my classmates. If there was any disagreement, we would recall what the teacher said and check the exercise again and again until the problem was solved" (018).

The gifted program also developed students in a holistic way, concerning psychology, oral expression, etc. The IT curriculum integrates learning in various subject areas, such as astronomy, history, literature, science, and geography. The students' comprehensive abilities are thus improved. Student (019) made the following remark regarding this point:

"I have to present my work to others and make them understand what I did exactly, which enhances my communication skills. Also, there are many problems that require me to discuss with others and work together to find solutions" (019).

The program has practical benefits. Both students and teachers value the role that IT knowledge plays in the college application process, especially for institutions that recruit independently, do not use national university entrance examination scores, and determine their own selection criteria. According to data collected in this study, gifted IT students from Yichuan High School have won over 400 awards in a variety of IT competitions in China since 2011. The awards pertain to webpage making, programming, computer artwork, technological innovation, among other areas. Student 001 reported having won the first prize in the "Casio Programming Contest" and the "'Western Group Cup' Computer Operation Competition for Adolescents." Student 002 said that he once earned the third prize in the "Web Page Design Contest" on the theme "National Information Technology Innovation and Practice for Students of Primary and Middle School." Eight students believed that taking the IT gifted program would benefit their college admission. Student 014 said that colleges would regard him as a student who could do great research in this area in the future. Student 023 believed that it would pave the way to better colleges. Student 004 commented the following:

"Specializing in computers helps us to enter good colleges. There were many awards given in this field every year, and I got one. So, I got a nomination from the headmaster, which made me feel a little relieved in Senior Grade 3. I did quite well on the final examination with less pressure. Finally, I was accepted at a college that is better than my scores merit" (023).

The students' comments show their appreciation for the program, which helped them cultivate the abilities valued by colleges, especially independent deep thinking and problem-solving skills, ultimately helping them to get into good higher education institutions.

Teachers recognize differences among students

The teachers were also affected by their participation in the Experimental Class for gifted IT students. By sharing practical experiences and discussing how to continually improve the gifted program, teachers not only achieved their goals of professional development, but also gained an unforgettable teaching experience.

The teachers gradually constructed their own teaching model of gifted education, including a management model, teaching materials, and teaching methods, to make the cultivation of gifted IT students' abilities a more familiar process for the teachers. In terms of teaching management, they formed a set of standardized operational systems. The school held several seminars on discussing "how to identify gifted students," "how to design appropriate curricula," and "how to train students to balance academic courses and training for IT competitions." The teachers had good knowledge of selection through assessment, lesson planning, and reward systems.

Teachers in Yichuan Senior High School had created a set of school-based teaching textbooks, which was the key point of their project research over the past six years. Each teacher in the research group had collected a great amount of teaching materials and exercises. What is more valuable is that teachers spent much time selecting and reorganizing these materials after applying them in teaching; they tried to identify the best teaching materials for gifted IT students in the school. Besides computer program exercises in high-level languages, teachers collate knowledge on computerized algorithms and write textbooks of important or difficult information deep searching and breadth-first search algorithms. It is possible for the students to read all the teaching materials with detailed explanations independently, which helps develop their self-study abilities. More than a dozen teaching materials cover all aspects of computer science knowledge, four of which have already been published.

With respect to the teaching method, teachers focused on "attention to differences." The teachers paid attention to the different relationships between teachers and students, disparate teaching forms from ordinary classes, and they encouraged students' performance in accordance with their aptitudes to achieve students' comprehensive development, enhancing the effect of the program.

Last, on the teaching system, teachers work as assistants and increase both the extent and the diversity of the services offered to the gifted IT students. Both selecting what to teach and how to teach it helped the teachers make sense of important ideas about actual teaching. The teachers carefully selected appropriate knowledge and skills that represent the subject's essence and supported student learning and application.

Discussion and Conclusion

This study found evidence that the IT gifted program at Yichuan High School in Shanghai is effective. Most students in the experimental class really enjoyed the program and viewed it as exciting and beneficial. It is possible that some students involved in the programs felt stressed; however, the majority greatly benefited from these experiences. Both teachers and students firmly believed that their experiences in the IT gifted program would enable them to do better in other subjects and in preparation for college admission. Gifted education infused them with a feeling of satisfaction and stimulated their confidence and motivation in other academic areas. They achieved positive outcomes not only from a psychological perspective but also through improved abilities. Most participants, particularly students with previous academic success, felt ready for gifted education when they were chosen, because most already had computer experience, did well in other subjects, and had great interest in IT. After taking the classes, some students reported that they were finally progressing in the areas of self-study, motivation, collaborative learning, and confidence. Moreover, some students acquired a new picture of computers and IT and a positive attitude toward gifted education in IT. Many students had also won awards in numerous competitions, which gave them a competitive advantage in the college admission process.

In addition, due to their participation in the IT gifted program, the teachers also gained valuable teaching experience. Their practical knowledge was enhanced through the process of reshaping their existing pedagogical knowledge and classroom practices. Just as Richards (1996) stated, when teachers talk to others about their teaching, they present their view of the ideal teaching environment, which is a type of reflection desired by teachers. By reflecting on their experiences with students in the IT gifted program, the teachers generated their own knowledge of teaching. They applied this knowledge and tried a variety of methods in class management and reorganizing teaching content to meet students' needs. Since 2004, teachers at Yichuan High School have continuously carried out practice in gifted programs and combined practical knowledge to cultivate the skills of gifted youngsters. Meanwhile, the teachers also formed teaching and research groups to explore ways to improve the development of both teachers and students. During the process of gifted education, teachers have greatly developed practical knowledge, which Tamir defined as the integration of knowledge in the professions with personal experiences and knowledge gained in teaching practice (Tamir, 1991). These improvements in teaching were also based on the setting up of the gifted program that could apply to other subjects and fields.

Based on the students' and teachers' perceptions, it was found that this strategy helped them in different ways, including identifying their own strengths, improving their motivation to study, developing a deeper understanding of a specific subject,

and improving teaching holistically. These findings indicate that programs like this should be promoted to enhance students' awareness of their own strengths and turn it into a learning model that could solve problems and encourage students to use their critical thinking abilities, even in other fields. The IT gifted program serves as a good example for the cultivation of gifted learning in other subjects.

It is also possible to expand the scope of gifted education, so that it benefits more students from different levels. Student interests, potential, and motivation, as well as creativity, were viewed as the main elements for student selection, rather than IQ scores, and the development of students' IT knowledge, techniques, and problem-solving abilities were the main targets of the program. The findings of this study also confirmed Renzulli and Reis assertion that that gifted students need "a wide variety of educational opportunities and services that are not ordinarily provided through regular instructional programs" (1986), in order to integrate their areas of giftedness. Research has also indicated that many of the emotional or social difficulties that gifted students experience disappear when their educational environment is adapted to their level and pace of learning (Neihart *et al.,* 2002). This demonstrates the absolute necessity of implementing gifted programs. Not only will gifted students benefit from them, but teachers will too.

Recommendations

In recent years, along with excellent progress and extensive application of Information Technology, new areas such as Internet Plus, Big Data, Artificial Intelligence, and Virtual Reality Technology have emerged and rapidly changed people's daily lives. An increasing number of researchers also expect a revolutionary change in teaching and learning (Herold, 2016). New models such as Ubiquitous learning, Borderless learning and Deep learning have emerged, and school types such as AltSchool have challenged the modern education system. There is no doubt that students and teachers will spend more time in learning to apply information technology to both learning and teaching, in order to adapt to a technological environment created by new IT innovations. Increasingly, the signs indicate that IT Gifted programs only for some gifted students will no longer be appropriate for schools in the future. However, these programs have helped accumulate a wealth of experiences for learning and teaching information technology. These significant experiences will guide teachers to teach more efficiently and help students to learn more cooperatively, as teachers and students involved in this IT gifted program have demonstrated and testified.

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