

ABSTRACT

Talent development of gifted youths and adults in science and
technology and comprehensive policy suggestions II:
An analysis of the academic status and career path of
science high school students and graduates

Meesook Kim

Yewon Suh

Heehyun Lee

Kyunghee Choi

Younggi Choi

Il Kim

This research is designed to elicit comprehensive strategies for developing and nurturing the gifted youth and adults(15–45 years old) in science & technology, as the second year of a three–year research project. The purpose of this research is to trace the status of their studies and careers on the basis of basic data established as a result of the first year research on the students and graduates of 21 science high schools and Korea Science Academy of KAIST, and to find and conduct multidirectional analysis of various factors affecting natural sciences and engineering

careers. The research tasks to accomplish this purpose are as follows; 1) How are the academic and career status of the gifted youths and adults in science and technology, focusing on science high school students and graduates? 2) What are the positive factors which help with careers and activities of natural sciences and engineering, and what are the negative factors which cause career dropout or avoidance? In order to answer the research tasks, literature reviews and expert discussions were conducted. Also, both questionnaire survey as a quantitative method and in-depth interview as a qualitative method were conducted on 3 groups of 'science high schools students', 'university and graduate school students', and 'the employed.' The results were used to analyze the status of their studies and careers. And on the basis of this analysis result, positive and negative factors affecting their careers in natural science and engineering were elicited and analyzed.

Research results are as follows;

First, the information obtained on the backgrounds of those surveyed is as follows. In case of science high school students, the proportions of male and female students showed 75% and 25% respectively, revealing that female students are still alienated in natural science and engineering fields. On the whole, the parents of science high school students and graduates had academic backgrounds of at least 4-year university and their fathers had semi-professional jobs and their mothers were mostly housewives. It turned out that the genders, occupations and academic backgrounds of their parents didn't generally affect their decisions on future occupation and natural science and engineering careers. However, there were slight differences in the future occupations, with slightly more

proportion of students selecting engineers as their future occupations in case they had parents with academic backgrounds less than 4-year university. Approx. 80% of the gifted in science and technology answered that their high school records were in upper middle level.

In case of university or graduate school students, approximately 93% stayed unmarried and 6.5% had less than 1 child among the married students. On the contrary, 52% of the employed were married with more than 1 child. When asked about the positive and negative factors affecting their careers, the university and graduate school students in their 20s before marriage answered a little differently. The male students answered that marriage and child raising would positively affect their careers, whereas the female students answered that marriage would positively and child raising would negatively affect their careers. As for the parental influences, those students who had parents with academic background of at least 4-year university and semi-professional occupation answered that marriage would affect positively but child raising, household affairs, and military service would affect negatively. On the contrary, those students who had parents with academic background of less than 4-year university and not-professional occupation considered the marriage and child raising as positive factors.

The results of the research on academic status and career path of science high school students and graduates are as follows;

First, the result of the research on level of interest in mathematics and science and on its relevant aspects showed that the science high school students had the highest level of interest in mathematics and 'normal' level of interest in 16 study areas. As for the fact that the students had 'normal'

level of interest in their studies, there is room for improvement by finding the in-depth reason why they had no higher level of interest. For the level of interest by study areas, the students appeared to have interests in various areas, not just focusing on one area. Considering this result, it seems suitable that more abundant and holistic ground of education would be prepared for the students by letting them experience various contents of study areas rather than just providing them with educational contents directly related to natural science and engineering such as mathematics and science.

As the factors affecting the level of interest in studies, research was also conducted focused on genders, occupation of the parents, and satisfaction in school education. Gender differences appeared to exist in all areas of science subjects, humanities and arts, experiment, and information/information science, except the interests in Science History. Particularly, female students had more interest in Science subjects, Humanities and Arts subjects, and experimental subjects than male students, but male students had more interests in Information/Information Science than female students. Whether or not the parents had professional occupation had nothing to do with the level of interest of the students. The students who were satisfied with school education also showed higher level of interest in their studies. Particularly, the level of satisfaction in school education well predicted the students' level of interest in science subjects and experiments. The analysis of each questionnaire item showed that knowledge in natural science and engineering areas, interest increase, and satisfaction in individual counseling were associated with students' level of interest in science, humanities and arts, and experiments. It was revealed that students' level of interest in information/information science was related to their scientific aptitude and

level of satisfaction in individual counseling. As for the specific reasons for their school satisfaction, the students answered that they liked R&E program of science high school very much, showing great satisfaction in the way they get information on universities and careers through the career counseling provided by the school and through interactions between seniors and juniors. Besides, the students also showed satisfaction in curriculum, facilities, and educational methods of science high schools. Accordingly, it is considered necessary that science high schools should try to gradually improve the students' satisfaction in school education while properly maintaining current system of school education.

Second, the analysis result of status of satisfaction in school education and majors and its relevant aspects showed that the students were generally satisfied with school education with at least 'normal' level of study interest and class satisfaction after they entered science high school, and the university and graduate school students were also satisfied with their majors on the whole. The analysis result of class satisfaction by subjects of science high school students revealed that most of them showed the 'normal' level of satisfaction in 5 subjects such as Mathematics, Physics, Chemistry, Biology, and Earth Science. Among above 5 subjects, they had the highest level of satisfaction in mathematics, but showed the lowest level of satisfaction in physics, with no great differences of satisfaction between the subjects. It was shown that the students were satisfied with the class where they had many opportunities to participate in class activities such as experiment, discussion, and presentation, and the class dealing with contents with high level of difficulty in interesting and various ways. Meanwhile, they showed lower satisfaction in simple lecture-oriented class, explanation-focused class, and class with no

experiment or research activities.

University and graduate school students showed no gender differences in their satisfaction in majors. More specifically in the level of satisfaction in their majors, the university students showed satisfaction in the contents of curriculum and lectures, the students in master's degree course showed satisfaction in the curriculum, and Ph.D. students in RA/TA opportunity, labs and research facilities, and lectures, etc. While the students who thought that their current majors had better prospect for employment and could contribute to society showed high level of satisfaction in their majors, those students who answered that they wanted to change their majors showed low level of satisfaction in their majors. Particularly, the students who selected medicine as their future majors showed high satisfaction in their majors, and most of them answered that they had bright prospect for employment and could contribute to society, and that they were proud of their majors. As for the reasons they selected their majors, they said that their majors correspond with their aptitudes and interests, and some of them answered that their majors could contribute to development of science and technology and to society as well, with growth potential in the future. Through this analysis result, it was demonstrated that the students selected their majors according to their aptitudes rather than other people's influence because they had very clear opinions or confidence in their majors. But as they grew older and their academic careers developed, they experienced some changes in choosing their occupation and career, and particularly, the phenomenon that the number of students who hoped natural science as university majors in their high school period gradually decreased as they moved on to Ph.D. period is something to be concerned, which can be interpreted as reflecting the

reality of a negative future of careers and occupations for those students who have natural science majors rather than reflecting the change of their aptitudes. Even though their satisfaction in current majors showed more than average level, but considering the average points of 3.57 out of total 5 points, it would be necessary to conduct closer investigation into the areas where students feel unsatisfactory and to arrange the subsequent complementary measures.

The research on educational satisfaction and effects such as how much helpful science high school, university, and graduate school educations were to next stages of academic development, study, and career showed more than 4.0 points of total average, revealing that those surveyed were satisfied with all of their education in science high school, university, and graduate school. But looking in each stage, it appeared that the education of previous stage had high effect on academic development and study, whereas it had comparatively low level of satisfaction helpful to current occupational accomplishment and work. As for specific reasons for their satisfaction in science high school education, they showed high level of satisfaction in various educational aspects such as educational methods, educational environment, and friendship formation. They also felt that education related to academic development and career guidance were helpful in reality. But crippled operation of school curriculum focused on university entrance exam were pointed out as malaises preventing the construction of balanced thinking and creative knowledge of students. Accordingly, it is necessary to conduct the education which can maximize the talents and gifts of students from the stage of science high school escaping from the education focused in university entrance exam, and to provide the students with broader, more various, and more active opportunities for learning so that the education in each previous

stage can be helpful to the next stage academic development and study, and for the future.

Third, the analytical result of situations and aspects of future university majors showed that approx. 80% of science high school students selected natural science and engineering as their future university majors by their own decisions, and considered the talent and aptitude as the most important reasons for their choices. As it was found out that the most important factors deciding their university majors are their own talents and aptitudes, if they are led to find the areas which they like and feel interested in and to keep continuing the areas, it is expected that there will be no big problem in guidance of academic development to natural science and engineering and their career counseling in their stages of high schools.

When asked about their future majors, approximately 84% of the university students answered that they had preferred natural science and engineering when they were science high school students, but the proportion of university students who are selecting natural science and engineering as their future majors decreased to approximately 76%. From this difference of 8%, 4% of students, which are half of 8% students, answered that they would select medicine as their future majors, revealing that the number of students who wish to move to medical school after they change their majors in their university period is ever increasing. In case of master's course and Ph.D. course students, 90% of them answered that they had preferred Natural Science and Engineering as their future majors when they were science high school students, approx. 94% of them when they were university students, and more than 85% of them when they were master's and Ph.D. students. More specifically, data of the students who

didn't select natural science and engineering as their majors were reviewed. As the result, 45 university students who answered that they would change their majors to medicine were influenced by their parents, with the stability of the occupation as the most important reason of changing their majors. Considering this trend of change, it appeared that some students wanted to change their majors to medicine because of its occupational stability, when they were greatly influenced by their parents. But those students who chose natural science and engineering as their future majors were sticking to their future majors consistently from their high school periods to master's and Ph.D. students periods. After all, it was their university period when the most students who wanted natural science and engineering as their majors shifted their careers, many of whom wanted to move to medical schools. The most influential factor to this phenomenon is the stability of occupation in the field of natural science and engineering, and unless this problem is solved, it is hardly expected to prevent the breakaway of excellent natural science and engineering students.

Fourth, as the result of research on the status of future occupation and relevant factors affecting it, it was their own talents, aptitudes, and interests that the most greatly affect future occupations of the students in all stages. In case of science high school students, educational satisfaction in science high schools also positively affected their future career choices. But for the employed, the income, stability, working environment, and social status other than aptitude and interest also greatly affect their selection of occupations. Therefore, it seems necessary to establish measures for the factors affecting future occupations.

As for the future occupation of science high school students, the occupations most wanted by the students include scientists and engineers.

Some also want to become doctors and economists. University students had preferred scientists and engineers as their future occupations when they were high school students, but as they entered universities, they changed the order and preferred the engineers as their first priority occupations. This tendency continued also in the periods of master's degree and Ph.D. degree and it appeared that the engineer was the first priority future occupation in each group except the period of science high schools.

In case of science high school students, they appeared to select natural science and engineering as their future occupations depending on their satisfaction in science high schools and the extent of support of science high schools for their advancement into natural science and engineering areas. Further, those students who knew annual salary and future prospect of their future occupations, and the suitability of their aptitudes (characteristics) answered that they would select science/natural science and engineering occupations. But most students didn't fully understand the detailed aspects of their future occupations such as work characteristics, working environment, and annual salary, and perceived the free research environment as the most important condition for selecting their occupations, which showed that they lacked practical and specific information about occupations. In order to make students stick to their natural science and engineering careers and occupations, it is considered necessary to provide them with precise and proper information about future occupations and careers and help them select their occupations on the basis of the information.

University and graduate school students answered that their majors correspond with their aptitudes with great social contribution and they are proud of their majors, but it appeared that their majors do not affect their selection of natural science and engineering occupations as their future

occupations, which shows that there is little relationship between inner perception of the major and actual selection of occupation by each student. But in case of university students, it turned out that their practical experience in business sites and TA/RA experience affect their future selection of natural science and engineering occupations. So, practice-based work site training is considered necessary for students. Most of their future occupations were professors and researchers, and they considered the aptitudes and talents are important, with their selection of basic natural science occupations being decreased compared to their high school periods. This has something to do with the level of income of occupations, which reflects that economic compensation affects the selection of occupations. Thus, it is necessary to provide practical support on which the students can pursue their talents and aptitudes. Without these efforts, the career stoppage or breakaway of the gifted human resources in science and technology fields seems inevitable.

In case of the employed, most of them replied that they had preferred scientists and engineers when they were high school and university students, but didn't reply on their preferences in the periods of master's and Ph.D. degree students, which partly shows the great distress of graduate students just before their employment. As for the occupational satisfaction of the employed, they were generally satisfied with their occupations, not thinking about the changes of their occupations. But in case of the employed considering the change of their occupations, the workplace satisfaction survey revealed that they are not satisfied with current workplace because of low social status, difficulty in self-development, low level of achievement, low independence, and insufficient research facilities. These are the important negative reasons they avoid natural science and engineering

careers.

In research on the factors affecting occupational satisfaction of the employed, it was revealed that the satisfaction in their everyday lives as well as their satisfaction in their work places are the important factors, which suggests that their satisfaction in their overall lives as well as in their works is also important. For this, it is considered necessary to educate the science& technology human resources so that they can be balanced in their families and society as well as in their works and studies.

The research results on positive factors helpful to natural science and engineering careers and activities and negative factors which bring career dropout or avoidance are as follows;

As the result of analysis of positive/negative factors affecting natural science and engineering careers, the positives included 5 factors such as aptitude and talent, educational satisfaction in science high school/university/graduate school, marriage, child raising(in case of males), and the level of understanding of one's own characteristics and occupation, and the negatives included 9 factors such as the income(low financial treatment), occupational stability, working environment, social status, the possible level of self development and achievement, parental influence, military service, child raising(female), and burden of household affairs. Child raising acted as positive element to males but turned out negative element to females. The employed mentioned low independence in workplace, poor research facilities, low social and economic status, little opportunity of self development and achievement as negative factors making them consider the change of their occupations.

Science high school students and graduates replied that they entered

natural science and engineering related schools because their talents and aptitudes corresponded with the fields and they would select natural science and engineering occupations as their future occupations. This positive attitude for natural science and engineering was consistently maintained through satisfactory education from science high school to graduate school. Marriage also acted as positive element, but child raising still acted as negative element to females, for which child raising policy is considered necessary on governmental level. On the contrary, marriage and child raising turned out positive factors giving psychological stability to males, but household affairs and the problem of military service acted as negative factors. So long-term alternative is considered necessary for the problem of military service of the students who want natural science and engineering careers.

In putting the analysis result together for the positive and negative factors affecting natural science and engineering careers, individual characteristic factors such as interests, curiosity and aptitudes in relevant fields had the most positive effects on university and graduate school students, and social recognition and respect to natural science and engineering also acted as major positive factors. In case of the employed, the most positive factors affecting natural science and engineering careers turned out to be individual tendency and characteristics, with interests and aptitudes in their majors playing decisive roles in determining and continuing their careers. Besides, families, schools and other social and cultural factors also had positive effects.

In negative factors, social and cultural aspects such as poor treatment and negative recognition for natural science and engineering acted as the most negative factors for university and graduate school students. Recommendation

of their families and poor school education also negatively affected them. As for genders, male students recognized the military service as negative element critically affecting their careers whereas female students recognized unfriendliness to females and the problem of child raising as the negatives. In case of the employed, working environment and conditions, and social and cultural characteristics turned out to be the most negative factors. However, the most fundamental negative factor was the low income in economic perspective. Also, low social recognition of people working in natural science and engineering field and widespread materialistic values in the society also turned out to be negatively affecting their careers. Further, poor work environment and limited career path in the field also acted as negative factors.

Among various factors affecting natural science and engineering careers, improvements are considered necessary particularly for negative factors. The excellent human resources should be helped so that they can have occupations suitable for their talents and aptitudes after they complete their educations. In Korea, the kinds and number of occupations which can be selected by the students with science and engineering majors after they graduate from universities or graduate schools are too limited. In order to solve the problem of low interest in natural science and engineering careers, the government should recognize that practical job creation is important rather than focusing only on education.

One more thing to consider is the necessity of improvement of social recognition for scientists and engineers. In Korea, the engineers in corporate research centers are not recognized as scientists but treated as common employees, with no recognition of their professionalism of scientists/engineers. Besides, the reality is that their work independence is not secured, with poor

work environments. In order to solve these problems, various natural science and engineering occupations should be created on governmental level in the first place, and the professionalism of the researchers should be recognized and retirement age should be guaranteed on company level. Social and cultural awareness of scientists and engineers working in the field of natural science and engineering should be enhanced.

On the basis of above results obtained from the second year research, the ways and implementation strategies for life-span education for gifted in science & technology will be suggested in the third year of the research. Policy recommendations will be made for synthetic ways and implementation strategies for life-span education of science & technology human resources by exploring the factors affecting their natural science and engineering careers and ways for revitalization of their influx through delphi survey and experts council, and by suggesting models connected to life-span education of the gifted in science.