Cultivating Self-motivation and Creativity for Precollege Students by Participating Science and Engineering Research

Jong-Duk Kim[1], Bum Jin Yi[2]

[1]Department of Chemical and Biomolecular Engineering,
[2]Institute for Gifted Students, KAIST,
335 Gwahangno, Yuseong-gu, Daejeon, 305-701, Korea

jdkim@kaist.ac.kr[1], bumjinyi@kaist.ac.kr[2]

Abstract

The research and education (R&E) program of high school student s in Korea was briefly introduced for the understanding of basic principal and operational process such R&E program in KSA and high schools. Since 1983, the cooperative research concepts at high schools was accepted when the high Schools were created and in 1992 the group research and education activities at Science High Schools were supported by KAIST. Since 2002, this program is operated within a frame of triad R&E team, directly participating in advanced research at universities. The R&E program will be greatly helpful to self-motivate research involvement, to cultivate creative thinking, to nurture the personal character, and to promote the cooperative research.

* Professor and Coordinator of R&E project in 2004,2005, and 2006
kjd@kaist.ac.kr

The research and education (R&E) program of high school student s in Korea was briefly introduced for the understanding of basic principal and operational process such R&E program in KSA and high schools. Since 1983, the cooperative research concepts at high schools was accepted when the high Schools were created and in 1992 the group research and education activities at Science High Schools were supported by KAIST. Since 2002, this program is operated within a frame of triad R&E team, directly participating in advanced research at universities. The R&E program will be greatly helpful to self-motivate research involvement, to cultivate creative thinking, to nurture the personal character, and to promote the cooperative research.

* Professor and Coordinator of R&E project in 2004,2005, and 2006
kjd@kaist.ac.kr

Introduction

The research and education (R &E) program is an unique program[1] of Korean high schools for gifted students to participate the research in order to cultivate the scientific creativity started in 2002 [2,3] . A group of high school students will form a research group with a teacher and/or professor and perform a research work of advanced topics at college laboratory. In present, KSA[4] and Science High Schools(SHSs) are in operation with more than 150 projects[5] , and

[1] KSA R&E reports, 2002,2003,2004,2005, 2006

[2] J.D. Kim, Coordinator of R&E project in 2004,2005, and 2006, This program at KSA started at the beginning of school in 2002 at Busan Science High School.

[3] H.S. Choi, Report, Enriching creativity for science-gifted students by research and education(R&E), KOSEF, 2003.2

[4] KSA is now moved its affiliation from office of education in Pusan to KAIST by modifying KAIST law in 2009

[5] J.D. Kim, The R&E program at KSA and SHSs are fundamentally identical but slightly different because KSA program is compulsorily enforced but those at SHSs are voluntarily selected. M.H. Kim, Mentoring creative research, 2004.2

[6] J.D. Kim, 1992. KAIST has supported the group research program for gifted students at Science High Schools at Institute for Gifted Students, and the groups of students about 20 teams did the experiments and presented their results at SEE-KAIST or final reports under the teacher's guidance. After reviewing the reports, the best works were awarded by President of KAIST.

encouraged to expand this program to other schools. In 1992, Institute for Gifted Students began the group research program at science High Schools[6] and a team composed of several students under a supervisor, which was, however, difficult to access the advanced research topics, facilities and scientists.
In this presentation, a new group research of R&E program for gifted students will be introduced. This program started as Korea Science Academy(KSA) outset in 2002.

Enrichment and Acceleration

The gifted programs might be originated with Plato(427-347 BC), who believed in an intellectual elite, and in the reign of Chinas Tang Dynasty (circa 618.), and Silla (wharang), child prodigies were delivered to the imperial court where their gifts were nurtured and developed. Throughout the Renaissance, creative talents in art, architecture, and literature were supported by both the government and private patronage. In the 20th century back to 1918, the program might primarily consist of acceleration for students needed it and in 1924, the formal gifted programs concern for the education of gifted individuals, when "The Education of the Gifted" was published by the University of Chicago Press, and the first systematic approach to providing for "bright pupils" was developed by the Superintendent of Schools in St. Louis, Dr. William T. Harris. In his reports, he commented on the advantages of promoting pupils at short intervals, as short as five weeks in the lower grades and of accelerating gifted pupils through the grades. He noted that the plan provided gifted pupils with more challenging work and prevented them from acquiring habits of laziness[7] . Lewis Terman[8] adapted Alfred Binet's intelligence test into Stanford-Binet test and created the term "intelligent quotient (IQ)".
Until 1957, the American public opposed federal aids to schools but Sputnik gave impetus to the public awareness for more advanced content in mathematics and science in USA and helped fuel the National Defense Education Act in 1958. The debate reached a turning point in favor of those who recommended greater emphasis on higher academic standards in science and mathematics. In 1972, The Marland Report was issued to Congress noting the deteriorating state of gifted and talented education, and later, they established Institute for Research and Policy on Acceleration in 2006.
The children capable of high performance would be generally accepted in General intellectual ability, specific academic aptitude, creative or productive thinking, leadership ability, visual and performing arts, psychomotor ability. The instrument to activate such giftedness may be optimized by providing the proper schooling opportunity.

1) Hobby; an extra intellectual challenge outside of school hours.
2) Enrichment; a modified assignment provided by the regular classroom teacher, Odyssey of the Mind, Destination Imagination or academic competitions such as Brain Bowl, Future Problem Solving, National History Day, science fairs, or spelling bees.
3) Compacting; skip repeated exercises
4) Self-pasing; Montessori Method,
6) Acceleration;
7) Part time pull out, extra classes
8) Part time(summer) school
9) Full-time separate classes or schools

Among diverse models for gifted education[9] , Renzulli proposed the school-wide enrichment model with three en-

[7] Passow, A. Harry (Ed) (1979). The Gifted and the Talented: Their Education and Development. The Seventy-Eighth Yearbook of the National Society for the Study of Education. Part I. 473P. Chicago: University of Chicago Press, 5801 Ellis Ave. Chicago, IL 60637

[8] Lewis Terman was the father of Fredrick Terman, who submitted the "Survey Report on the Establishment of Korea Advanced Institute of Science" to USAID in 1970 as Stanford-Silicon Valley Model. Later, KAIST interestingly initiated the education for the gifted students in Korea as his father did.

[9] Stanley & Benbow(1983), The talent search model for Talent Identification and Development, Renzulli(1988), The Schoolwide Enrichment Model, Betts and Knapp(1980), The Autonomous Learner Model, Gardner(1983). The Multiple Intelligence Model, Feldhusen and Kolloff(1979) The Purdue Three Stage Enrichment Model for Elementary Gifted Learners and The Purdue Secondary Model for Gifted and Talented Youth. Kaplan(1986). The Grid, Maker and Nielson (1996), The Matix, Meeker (1985). The structure of Inteleect Model, SOI. Schlichter(1986), The Models for Talents Unlimited , Inc and Talents Unlimited to the Secondary Pouw, TU2, Sternberg (1981), The Triarchic Componential Model, Van Tassel-Baska (1986). The William and Mary

riching stages to achieve this goal[10] , while GERI(gifted education research institute) applied three stages for the pull-out program[11] . In last stage, both education models for gifted students may begin with confronting real complex problems, where students resolve cooperatively the real problems and discuss the diverse processes for solutions. Thus, students participate in learning processes; resolving the problem, accumulating new knowledge, and cultivating thinking and creativity.

In 1981 and 1982, Office of education, Gyeonggi-do opened summer camps with 30 students selected from middle and high schools (9-10 grades) and the participants were requested to perform a group cooperative research and brain storming, and concluded that students are capable of intellectually creative work, weak in synthesizing collected information, enough to do experiments, and need to promote the ability for creative research, and first founded the Science High School in 1983[12]

Cooperative Studies at High Schools

After the foundation of Gyeonggi Science High School, and other Science High Schools, the schools accepted the concept of gifted education in program[13] , such as enrichment and acceleration, compacting, full-time separation etc. KAIST started to give admission for graduates and early completions since 1987 by accepting the acceleration curriculum. However, the activities of Science High School are limited to the regular curriculum and need to be encouraged by the college. In 1992, KAIST supported the group research project[14] and requested a team report with 2 million won per team in High Schools which may be the first team research at High Schools or Universities and later the report was replaced to the presentation at SEE-KAIST[15] .

Self-motivated and Creative program

R&E program is designated for nurturing creativity in an education program of performing a self-motivated research, learning the scientific methodology for acquiring science knowledge, and bringing up the ability of problem recognition and solving. Thus, the object of this program is pluralistic such as

1) self-motivated learning of involving research,
2) cultivating the creative thinking,
3) nurturing the character and personality as researcher,
4) recognizing the cooperative research.

The self-motivation is the most important issue for teaching gifted students, and therefore, performing R&E program as well. The scientific creativity was defined in diverse concepts but cultivated with scientific contents, thinking method, and inquiry skills, but thus far the high school curriculum neglected to teach the thinking way and inquiry skill. The similar programs are SIR program at IMSA[16] and GILDER project week at Israel Arts and Science Academy[17] . R&E program will provide the opportunity for exposing this environment to KSA students. Since the real research is sometimes a pain-taking job to obtain a meaningful clue, the students must understand the value of hard working and cultivate the personal character and passion for science. Finally, modern science requires the cooperative research and team works to resolve a practical problem. The research organizations or industries recently stressed on the humane relationship and leadership for achieving better research performance.

Integrated Curriculum Model, ICM.

[10] Renzulli, J. (1977). The enrichment triad model; A guide for deveolping defensible program for the gifted and talented. Masfield Center, CT: Creative Learning Press.

[11] This program was developed for college education at Purdue University by Feldhusen, Linden and Ames in 1973, and extended and modified for education of the gifted students by Feldhusen and Kolloff, 1977.

[12] 20 years of Gyeonggi Science High School, 2003

[13] Gyeonggi Science High School, 54 students first graduated in 1986 and 9 had early admitted to KAIST.

[14] J.D. Kim, 1992, see Reference 6.

[15] SEE-KAIST was initiated at Electrical Engineering, KAIST 1995, but expanded as KAIST activity in 1998 as a fair of technology exhibition

Performing Research with a triad team[18]

In KSA, the curriculum composed of course works, self-motivated R&E and social service. As all programs were uniquely designed, the self-motivated R&E program composed of three steps of learning process; the first step is to enrich the knowledge by mentoring during the semester, the second step is to enrich it by observing the research during the visit across research institutes, and finally to enrich it by performing research by themselves. The mentoring was performed at the weekend during semester for 4 hours usually at KSA, 3 times a week, but during vacation, usually two weeks experiment session was performed at university laboratory with teaching assistants, usually graduate students. However, visiting programs to foreign countries such as Russia, USA etc, was scheduled during the vacation under a different coordinator.

A triad R&E team is composed of 3-4 students, advisor and co-advisor. The advanced topics and advisor was solicited from the universities nationwide and KSA. The R&E topics were proposed by professors or teachers in a given form of proposal and reviewed by a selection committee whether the topics are appropriate for high school students. After first round, the selected research topics are exposed for second round and selected by high school students, shadowing the advisors. This blind review will remove the unwanted prejudice toward advisors and focus on the research topics for his or her interests. The research teams will be constructed by applying a topic through internet[19] and decided as a team if the applicants are 3 or 4. This process continues until all the students are allocated at a proper topic. To have a successful operation within the group, it is very important that the project must be designated precisely in research goal, detailed process and role for every participant. Usually a team composed of 4 students, co-advisor, and advisor. Then, a teacher of KSA, who is nominated as co-advisor, will support the transport, scheduling, management of research and academic record and will have the cooperative research experience for advanced topics, while a professor as advisor will propose a topic and proposal, manage the research expenditure, and help the research planning, designing experiment and equipment operation to achieve the research goal. Also the advisor has the responsibility to help the mid-term and final report, and the final presentation for evaluation. However, it is very difficult to have enough incentives for professors. The students are requested to participate in all research activities for the topics and visiting programs, to keep the research data and note safely, and to present their research results.

Reminding of Research Safety and Ethics

Doing research is to work with unknown processes or materials, which may lead to the accidents and menace the life of participants. Before we begin any research program at laboratory, it is very important to remind the safety issue not only at doing experiment, but also at entering and leaving experiment zone. The safety issue includes fire, electricity, spilt, explosion, bodily damage, and computer hacking, etc[20].

Recording the experimental and genetic idea at research notebook is significantly important for keeping the basic and original data[21] . The record will protect the researchers from plagiarism in intellectual property right and integrity dispute in academic achievements.

Managing and Evaluation

The R&E program is a learning program via self-motivated research. The weekly activity of team research will be recorded at individual research note and reported monthly at research bulletin board of website by students and monitored the process during the semester. For mid-term report, we have sessions for oral presentation at early September

---

Academy(IMSA). Students participate in SIR through Mentorship, Plans of Inquiry or IMSA courses.

[17] In GILDER project week, students participate in the individual research with mentors consisting of teachers and professors.

[18] 2006 KSA R&E program proposal, 2006.3

[19] R&E homepage, http://rne.kaist.ac.kr

[20] KAIST guidebook for laboratory safety, 2005.2

with three reviewers including the advisor of the project team. The planning and understanding of project will be discussed summarizing the spring and summer activities. For final report, students are requested to submit the report and poster and to present it orally in front of two reviewers and general audience. The understanding of research scheme, self-motivated learning, creativity, and completeness are key factors for evaluating the projects.
Some of students published a academic paper in professional journal and won the research awards at the national competitions. The R&E program was highly evaluated[22] from KSA students, and KAIST freshman, who participated in the program at high school. Now the concept of the program was also applied to the University Research Program[23] .

Acknowledgement

The Cooperative research program for Science High Schools since 1992 were supported by KAIST and the R&E programs of KSA and SHSs are supported by Korea Science and Engineering Foundation(KOSEF), Ministry of Science and Technology, Korea.

References

01. Drake, S., & Burns, R. 2004. Meeting standards through integrated curriculum. Alexandria, VA: ASDC. Drake, S., & Burns, R. 2004. Meeting standards through integrated curriculum. Alexandria, VA: ASDC.
02. fhjfghj

[21] "On Being A Scientist: Responsible Conduct in Research," Committee on Science, Engineering, and Public Policy, National Academy of Sciences, National Academy of Engineering, Institute of Medicine, National Academy Press,1995 (http://www.nap.edu/readingroom/books/obas/). The Chemist's Code of Conduct (http://www.chemistry.org/portal/a/c/s/1/acsdisplay.html?DOC=membership\conduct.html)

[22] J.D.Kim, KSA R&E program Final Report, 2005.3. and Freshman Report KAIST, 2006.3

[23] J.D.Kim, paper presented at Conference of World Council of Gifted and Talented Students in Univ. of Warwick, UK, 2007 University Research Program(URP) started at KAIST 2007, and the national experimental program was performed at Insitute of Gifted Students, 2008 and operated nationwide in 2009 by Korea Creativity Foundation.