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THE POSSIBILITIES AND DIFFICULTIES ON R&E ACTIVITY FOR IMPROVING THE PROFESSION SKILLS OF SCIENCE GIFTED TEACHER

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Although over 600 students in Incheon has been participated in the gifted education programs under the colleges and Office of Education Department every year, it is reported that the number of teachers have insufficient teaching abilities in primary, advanced, and after-advanced gifted classes. The Gifted Education Research Institute in Incheon University introduced R&E activities for the improvement of teachers' abilities in science research and student guiding.

Professors in science department conducted the R & E activities to select the research thesis. The professors and the guidance teachers decided the directions of the research, and the guidance teachers who learned from the professors taught 3-5 students to practice the research. Five professor-teacher-student research teams in math, physics, chemistry and biology conducted the research after school and during the vacation for 7 months. The results of the research were submitted to the journals of research activities and the result papers were presented to the seminar. On this research, the possibilities and the difficulties of the R&E activities based of the journals of research activities, oral presentation and the research results reports were analyzed with a purpose of improving the professionalism of the science gifted teachers.

Although the professors proposed many difficulties or problems about the R&E activities, the teachers reported that the R & E activities helped them to improve their research activities and student guiding techniques. The teachers acquired more knowledge on the principles of the science related areas than before. Moreover, they thought it was very meaningful experience in using the science related instruments, guiding the students' research and writing the research reports. The students also gave the positive responses with the increased interests in new science studies and with the experience of learning the way of research.

1. Introduction of R&E activity in the gifted education teacher-training program

Teachers who will teach the gifted students in the elementary school and science subject need to know more on the gifted education, educational psychology, advanced science course, and science education in addition to their own work fields. However, there are no universities offering the undergraduate-level gifted education major within the college of education in Korea. The teachers can only acquire the basic knowledge of the gifted education by taking gifted education courses or in-service training programs offered in the graduate schools. Although 4~5 graduate schools of education including Kon-kuk University and Incheon University offer the graduate-level gifted education major, they are not sufficient to cover the increasing numbers of the gifted teachers. Instead, the science gifted education institutes in University, Korea Education Development Institute, and the Korean Society for the Gifted are offering periodic or non-periodic in-service training program for the gifted teachers.

In spite of the in-service training programs offered by several institutes, many researchers insist that there are not sufficient professionally trained gifted teachers who can teach scientifically gifted elementary and the middle school students. Within the sixty-hour in-service program offered during the vacation or semester, the teachers usually learn theoretical based gifted education in general and the knowledge of science. They do not have enough opportunities to discuss about the problems such as dilemma and judgment of value which might be occurred in

gifted classes because the number of trainees are about 30 in each class of training programs. Moreover, they have to obtain the results and conclusion within 4 hours in experiment classes of training, they cannot cultivate the leadership skills required for guiding students during the research or science study activity. Most of all, during the in-service program, the teachers do not have enough chances to observe the problems that can be occurred for the gifted in gifted classes and to learn of their coping strategies. The in-service program for the gifted teacher should be helpful directly in the fields when applied afterward and the teachers should receive the professional feedback right after the application, there is no in-service training institute which has those system.

University of Incheon has been providing the in-service programs for the teacher of gifted education since the winter vacation of 2003. The elementary school teachers participate in this program during the summer vacation and the middle school and science teachers participate during the winter vacation. For a year, 30 elementary and 30 middle school teachers receive the training for 60 hours in two weeks. Various courses related to the theory of the gifted education are opened as a common subject of math and science, and knowledge of major, theory of investigative activity, example, experiment practices and guidance practices of the scientifically gifted were offered for each subject (See Table 1).

Table 1. Curriculum of Gifted Education Teacher Training Program

Subject	Contents	Hours
Common	Identifying and Selecting the gifted	2
	Teaching model for the gifted	4
	Instructional and evaluative methods for the gifted class	4
	Develop the creativity of the gifted	4
	Understanding emotional aspects of giftedness	4
	Policy and school for gifted education	2
	Practice of identifying and selecting the gifted in mathematics	8
Mathematics	Developing the creative mathematics programs for the gifted	8
	Creative strategies for teaching mathematics to gifted students	8
	Practice of creative inquiry activities in mathematics	8
	Analyzing mathematics problems using micro-computers	8
	Practice of identifying and selecting the gifted in science	6
Science	Developing scientific inquiry programs for the gifted (Physics, chemistry, biology and earth science)	20
	Creative strategies for teaching science to gifted students	6
	Discussing scientific problems using science books	4
	Practice of out of school program for the gifted	4
Total		60

However, after the evaluation of training effectiveness, the necessity of the more advanced in-service program was recognized. It was found that the teachers were easy to teach the primary class of gifted student in classes opened by Office of

Education but were not easy for the students from the advanced classes or study program under the professor. This indicated that in order to teach the advanced students, math and science teachers should have not only professional knowledge in math and science area but also the teaching ability of gifted and science education, and science investigative or research ability. Therefore, University of Incheon has introduced the gifted teacher in-service program through R & E activity as a new advanced training program for the teachers.

2. Research activities that students participate

There are two kinds of experiments, an illustration and a research (Hwang, 2001). The experiment of illustration is mainly used for recognizing of the appropriateness and adequateness of the concept and the principle of the science that the students learn from the class to explain a natural phenomenon. As the experiment of illustration shows the adequateness of concept and principles of science, it can be performed without major difficulties and taking time, and failure possibility is low. In addition, there is a little chances of dispute arise because most of the phenomena of the experiment and the concept of the science correspond to each other. However, scientists attempt to discover the new phenomena and events through the experiment of research. They use this method to verify assumptions or disprove the theories that are lack of evidences.

Because most of science experimental activity in schools are the experiment of illustration, many teachers and students experientially think that they can realize the principles of science right after through the observation and the experiment (Monk and Dillon, 2000). Students think that an experiment was not performed correctly if the experiment results were not as they expected, and if they perform an experiment accurately, the results will come out just as the same as that of textbooks. Therefore, it seems to be impossible for students to discover a new phenomenon and make a new theory from the school experiment activity. When the school experiments were successful, students' interest, learning motivation, and self-confidence were improved, however, when they were not successful, students showed the negative attitude in affective characteristics (Park, 2002). As students expect immediate results from the experiment, it is very hard for them to

understand that the science has been developed in a very long period of time with great efforts, ideas, and arguments of the scientists. More over, it is even harder for them to understand the nature, pleasure of research, and improvement in intelligence, to cultivate the creative endurance from the science investigative activity.

To recognize the value from these science activities, the experiment of research is recommended rather than the illustration. For the successful experiment of research, the open-ended questions that are accustomed to the students but new and look marvelous, and that someone-friend, textbook, internet, teacher, or scientist-can not answer easily need to be handled (Park, 2000). It is recommended to start from the activities that connect to the basic science concept and principle if the teachers and the students do not know about the circumstances and the phenomena in their interested fields. If needed, the teacher and the students can receive advices and guidance from a helpful professor. Through these processes, if questions related to a new phenomenon are solved, the teachers and the students have done an experiment and a creative research as a researcher,

3. R & E activity at Gifted Education Research Institute in University of Incheon

The Gifted Education Research Institute in University applied the R & E activity to the teacher in-service program with expectations that it would improve the professionalism of the science teachers and promote the research activities of the students. The purpose of this R & E activity in University of Incheon are to improve the professionalism of the science and the gifted teachers in Incheon area, and to expand the creative and self-lead study abilities of students through the collaborative research activities among the academic advisers, guidance teachers and the students.

Although the systems of R& E activity in University of Incheon are similar to those of other science gifted schools, The major differences are in the role of the participants and the activities. <Table 2> shows the comparison between University of Incheon and BSA in R&E activity.

Table 2. Comparison between University of Incheon and BSA in R&E activity

	R&E in Univ. of Incheon	R&E in BSA
Aims	Improving teacher's abilities to solve the science problems and to guide the student inquiring activities	Enhancing the student's abilities of creative problem solving
Projects	Research activity in mathematics, science, and information technology	Research activity in mathematics, science, and information technology
Team Composition	Professor(1), teacher(1), general students(3-5)	Mentor(1), co-mentor(1), gifted students(3-5)
Roles of teacher	Selecting and teaching students, Guiding students' works, Studying research problem, and reporting research results	Teaching students, And Guide students' works

1) Composition of research teams for R&E activity

A research team for R & E activity in University of Incheon consisted of 1 professor, 1 guidance teacher, and 3-5 students. The professor who takes the responsibility selected a guidance teacher. The professor and the teacher discussed and decided the research projects with consideration of the intelligence of the students, prior knowledge, curriculum of the education, and then the teacher selected the students as a team member.

Five R&E activities proceeded in four science areas: math, physics, chemistry, and biology. The professors from the universities in Incheon area participated as leaders for R&E. The guidance teachers had prior experiences with the professor through the cooperative researches or completion the graduate program under the professors. The majors of the teachers and the professors were coincided. The teacher participants were 1 from a middle school, 4 from the high schools, and 1 from a school of science gifted. The student participants were selected from the schools that the teachers teach. It was hard to say all student participants were the gifted because the total of 18 students were 3 from the middle school, 15 from the high school, and 3 from the school of science gifted.

2) Overview of R&E activity

The R&E activities were conducted once in two or three week. During the semester, the professor taught the teacher in laboratories, and the teacher taught the students in class rooms, and the professor taught students the related subjects. During the vacation, the research activities including the theory, experiment, and practice were conducted in the professors' laboratory.

The subjects of the research areas were familiar to the teachers because the R&E activity and the projects were selected from the discussion and from the research projects that the professors and teachers were conducting together. The conducted R&E activities are shown in <Tale 3>.

Table 3. R&E activities in University of Incheon

Mathematics	Study on the Applications of Matrices	Professor in Mathematics (1)	General middle school, 8 th and 9 th grade (3)	General middle School teacher (1)
Physics I	Nano-fabrication and Characterization by atomic force microscope	Professor in Physics (1)	General middle school, 9 th grade (3)	General high school teacher (1)
Physics II	Study of R&E and managing program for corona discharge plasma	Professor in Physics (1)	General middle school, 9 th grade (3)	General middle School teacher (1)
Chemistry	Study on the heavy metal ion adsorption characteristics of natural and tideland clays	Professor in Chemistry (1)	Science high school, 10 th grade (3)	Science high school teacher (1)
Biology	Development of Protocol in Hand Making Natural Soaps	Professor in Biology (1)	General high school, 11 th grade (4)	General high school teacher (1)

3) The process of R&E activity

The total of five teams have conducted the researches in four subject areas of math, physics, chemistry, and the biology for seven months from June to December. The journals of activities were recorded by the professor, the teacher, and the students each whenever there was any activity and/or guidance among them. After the project was over, the journals and final reports were submitted, and the final presentation was made by oral. The procedures of R&E activity in University of Incheon were as follows.

○ The procedure

- 2003. 4. Selected four research areas and two research projects in R& E
- 2003. 5. Held an explanatory meeting of R&E
- 2003. 5. Request for proposal of R&E Study, selection of project leader, adjustment of plan and budget
- 2003. 6. Made the contract for each project and started the research
- 2003. 10. Collected the interim report of the each project
- 2003. 12. Completion of each project
- 2004. 1. Collected the final report of the each project
- 2004. 2. Presentation and evaluation of each project
- 2004. 2. Collect the final research reports with the evaluation results
- 2004. 2. Print the written final research report

4. R&E Results

Effects and problems of R&E activity in terms of strengthening teachers' professional expertise were analyzed based on the journals, oral and written reports.

1) What were the benefits of R&E activity for teachers?

Firstly, teachers felt comfortable with the experiment and manipulation as they were being familiar in using lab equipments and instruments during the R&E. Teacher D who was participating in R&E in chemistry reported in his/her journal that he/she became familiar in manipulating the high-tech instruments such as XRD and SEM/EDS. Teacher E who participated in R&E activity of biology reported that he/she was satisfied with his/her achievement in oil analysis using chromatography.

Secondly, teachers became to increasingly understand the high-level scientific principles related to the research projects. Although it was not easy to understand the principles of profound scientific research, they were able to learn considerably while they were studying and instructing students. Some teachers gave very positive responses in learning how to write research papers with the experiment results and in knowing there are several methods to analyze the results and its logical reasoning. Teacher A who participated in R&E activity of mathematics positively evaluated for the mathematical application into the real world practical problem solving.

Thirdly, however, some teachers reported that they did not adopt new instructional methods or devise novel instructional models. They explained the difficult scientific principles to the students and instructed them to do experiments. They did not practice any new instructional methods that help students think and learn by themselves. They also pointed out that the teacher's role as a supporter during the private teaching by professor need to be emphasized.

2) Did teachers take the initiative in R&E?

The person who played the most leading part in R&E was mathematics teacher A. Teacher A participated as a co-researcher, instructed students in matrices, and evaluated students who applied matrices theory to practical problem solving. He also presented the research results in place of his supervising professor. Teacher E is also a active participant in R&E of biology. He/She actively participated in analyzing the research results and preparing reports together with his/her students. He/she reported that his/her analysis and writing skills were improved.

Teacher C who involved in R&E of Physics did not played actively not only as a researcher but also as a teacher. He/she participated in the research not as a co-research and did not take a leading role. He/she only discussed about R&E with his/her supervising professor. His/her journals and reports did not show any of his major initiatives during the research. According to the research results presentation by the professor, co-working research was not easy to progress for this case. It was proved that this research project requires higher academic knowledge in physics and was not appropriate in a short-term R&E project.

Generally, enhancement in instructional and research skills was achieved in mathematics, biology, and chemistry. Acknowledging difference of levels, some teachers had more or less joy of inquiry and affective achievement like creative patience. However, some teachers did not contribute to research, even though they had participated in research and instructed students. To these teachers, research participation seemed only recognition of instructional objectives of each class.

5. Possibilities and problems on R&E for improving teacher's expertise

R&E gives in service teachers the opportunity to participate in cutting-edge science and technology research. However, if they have not been working as co-researchers, they don't have enough time to understand the research or chance to contribute. In that case they do more of instructing or managing students than performing research. Although R&E is not a creative one for scientists or

professors, teachers are able to perform some parts of the research as co-researchers when it requires much use of measuring and analyzing instruments. They are also able to understand the research process and present the results. However, if the research topic is the same as the teacher's own research, it is possible that the research becomes the teacher's autocracy rather than is instructive to the students when students' participation is low and the progress is not sufficient.

Choosing research topics that are appropriate for the students to understand and experiment is helpful for the teachers to participate in research and instruct students. In that case, students and teachers can lead the research and reach the conclusion with mere guidance of supervising professor. Teachers can get an experience and skills of teaching students how to make inquiries. Professor's critical advice is also needed for the research to be a unique one. The major problem of R&E is the gap between professors, teachers, and students. That is, professors cannot raise the level of research because they are not sure of the teachers' and students' competence, even though the professors can do unique and novel research in their field of interest with high-tech equipments and instruments. Moreover, it is very difficult to teach students and teachers profound scientific principles and concepts, which are not treated in secondary science curriculum. To bridge the gap, fundamental concepts and principles of the research must be learned. The first part of an R&E project needs be assigned for prior learning for at least 3 months.

6. Conclusion

The R&E activity provides the many possibilities to the teacher; accordingly, the roles of teachers can be various. Firstly, they have a chance to participate in the leading science and high level of the research activities. In this case, the teachers' prior knowledge and research ability should be very high. In order to obtain the creative research results from the R&E activity, the teacher should guide and train the students more than six months. Otherwise, it is just giving a chance the

student to have experiment experiences and the guidance techniques the teacher acquired get weaker.

Secondly, even though it is not the high level of research, the teacher proposes the research subject and progress together with the students using the tools in laboratory. The teacher can have a chance to perform researches, to study, and improve student guidance skills if they participate with enthusiasm.

Thirdly, The teacher receives real life's problem solving with the help of the professor in science. The teacher can progress the higher level and the creative research if there's appropriate choice in real life. There are much of the progress in the teacher's student guidance technique and the research ability if the professor approves the research, For this occasion, it is easier to have close relations between the teacher-student rather than professor-teacher. For example, the teacher taught the student in the group for a long time, and it is better to solve the suggested matter as the real life.

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