School Effects Analysis on Science High School

So-Young Park*

Sookmyung Women's University

Abstract

The purpose of this study was to see if science high school has effects on improving student's science achievement. The research question was from recent doubt about effectiveness of Korean education on science talented youth. To answer the research question, science achievement scores of general and science high school students were compared under the control of variables both at student and at school level. HLM(Hierarchical Linear Modeling) was employed for analysis. The results showed that students in science high schools showed higher numbers than those in general high schools in both raw scores and scores after consideration of controlling variables. Interests in science positively predicted achievement scores regardless of school type. The number of mother's schooling years and SES scores at student-level, and the school mean SES and school location at school-level were the significant variables that predicted achievement scores.

Key words: Science high school, policy evaluation, school effectiveness, the science-talented students, specialized school

I. Introduction

According to PISA results in 2006, Korea ranks from 7th to 13th in science, which is much lower than that of math and reading comprehension. In particular, talented students rank 19th

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* Hyochangwon-gil 52, Yongsan-gu, Seoul, 140-742, South Korea. syngprk@sm.ac.kr

in science among 57 countries, which is disappointing(OECD 2007). Looking at this result, it is possible to impose a question if there is a problem in the science education in Korea, especially in the science-talented education.

In Korea, education for excellence in science is offered through the Institute for the Gifted, which is supported by the local office of education in cities and provinces, through Educational Institute for Science Gifted Students, and through gifted classes that are supported by universities or colleges in elementary and lower high school level. In upper secondary school level, education for excellence in science is offered through science high schools. The original science high school in Korea has been founded in 1983, named as Kyung-Gi science high school, and since 1987, formal science high schools appeared in Korea in the purpose of special education for the students who show superior talents in science. By 2009, there are now 19 science high schools in cities and provinces.

However, based on the recent admission system in science high school and characteristics of the applicants, there is a tendency that students who want to go to prestigious universities apply to science high school in order to enter top universities more easily, rather than those students who apply to science high school purely because they are talented at science. People began to doubt even more about the science high school and its role as a science school when all of science high school graduates admitted to Seoul National University[1] in 1994. Also, the fact that the rate of graduates from science high school declaring major in science and engineering decreases continuously, partly proves the fact that science high school only plays a role as an elite school rather than school for the science-talented. Science high school is one of the policies that government has supported for educating science to young students who are specifically talented in science. Therefore, it is strongly recommended to investigate science high school and its efficiency in practicing its role as educating science to talented

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[1] Seoul national university is known as the most prestigious school in Korea.

young people.

Thus, the purpose of this study is to perform a policy analysis on the role of science high school to verify if Korean educational system has problems in science talented education that PISA 2006 science results imply. In order to analyze the science high school, based on the hypothesized goal of certain level of academic achievement for science high school, the analysis on the effectiveness of science high school has been conducted. The main question of this research is to figure out whether science high school can influence academic achievement in science. Also, in order to have more accurate results that reflect real structure of the data, this study has controlled the variables at both student and school level. This study is expected to contribute to improving policy on science high school by providing empirical data. This paper is composed of the process of foundation of science high school as well as previous studies on school effectiveness before starting the analysis.

II. Literature Review

A. History of Science High School

Science high school has been first founded in 1983 with the purpose of finding science-talented students, developing their creativity, and expanding their choices(Suh, H., 2006:10). In 1987, based on laws for elementary and secondary education, the science high school has been specified as one of the specialized high school, which has the right for its own admission system and programs(Kim, Y., 2003: 42-43). Initially, science high school was able to practice a special education in science which included creative science projects and research-oriented classes, without any worries about college admissions.

However, as more students from science high school were admitted to top-ranking colleges, many science high schools were founded in each city and province irresponsibly. After the number of graduates from science high school exceeded the number of students for enrollment in KAIST,[2] more competition

was triggered, and the main function of science high school as a special education in science has declined. Especially in 1994, after the news it was announced that all of the science high school graduates went to Seoul National University,[3] college admission system has been changed. The newly introduced admission system did not give any advantages to the science high school graduates, which brought many voluntary withdrawals from the science high school. This withdrawal happening made people doubt the educational purpose of the science high school.

According to the recent study on science high school, despite of the primary purpose of science high school of educating science-oriented curriculum to talented young students, it has been found that the curriculum of science high school is not quite different that of general schools. This illustrates that no specific support or supervision has been applied for science high school. On the other hand, the government established another type of science school for the science-talented neglecting the already existing problems in the science high school. In addition, some of local organizations are leading a movement of changing science high school to newly founded science-talented school. This led to many objections from the existing science high school. Therefore, it is necessary to establish a firm policy and management program for science high school based on research.

B. Research on School Effects

Coleman and his fellows conducted the research in school effect for academic achievement for the first time(Bryk & Raudenbush, 1992; Teddlie & Reynolds, 2000), and stated that school has almost no effect on student's academic achievement, which surprised the society very much. Later in London, Plowden report also declared that they found no school effects,

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2) Korea Advanced Institute of Science and Technology(KAIST) is one of the best colleges specializing in science and engineering education and research. At the beginning, science high school graduates are easily proceeded to KAIST under the contract.

3) The issue is that entrance in SNU does not guarantee that the science high school graduates will study science related major.

which led many follow-up studies(Teddlie et al., 2000). These initial researches on school effect has been criticized because they employed input-output model under which school's background variable is an input variable and academic achievement is an output variable. Consequently, those studies did not contribute in explanation and improvements of actual educational system at school(Teddlie & Reynolds, 2000). Therefore, recent studies include actual variables such as instruction variable and teacher variable taking input-process-output model. This model is favored because it gives information to improve the schools. Influenced by the recent model, this study also tries to include process variables at both student and school levels; therefore it is expected to improve schools in the end.

An important part in school effect study is a discussion of which part should be considered as school effect. Raudenbush and Willms divided 'Type A effects' and 'Type B effects'(1995: 309-310). According to Raudenbush and Willms, Type A school effects include geographical and socio-economic factors of school, whereas Type B school effects include only the within school factors. This typology needs careful approach in figuring out school effects that are expected. Thus, Type A school effects cannot be expected without influential factors that are outside of school, and Type B school effects can be expected within school only. Type B can be expected to improve factors within school through the study, hence this paper focuses on finding out Type B school effects.

In Korea, there is not much research on the school effects on academic achievement because achievement data are hardly gathered as an individual researcher. Despite of this difficulty, there are some research in Korea, such as Sung, K.(1997), Kim, Y., et al.(2006), Kim, S.(2006), and Lim, H.(2006). Sung, K.(1997) analyzed scores from 11th graders with through Hierarchical Linear Model(HLM). Kim, Y., et al.(2006) analyzed school effects with large sample of 11th graders in Korea based on reading, math, and science test scores. They controlled school level variables as well as student level variables. Kim, S.(2006) and Lim, H.(2006) are distinguished in that they conducted a

longitudinal study to find out "added" academic achievement after entering the high schools. Kim, S.(2006) analyzed students at 130 high schools for 3 years using actual gained achievement in high school. Lim(2006) also conducted an impressive study in that she analyzed the achievement scores for 6 years of 12th graders. As a result of analyzing longitudinal study of school effects, she found that curriculum tracking, ratio of tracking, ratio of girls, and specialized high school have influenced the initial condition of average achievement scores of school. Academic tracking, tracking ratio, and specialized school type also influenced on students' growth in achievement. In this study, specialized high school showed higher scores in achievement than general high school.[4] However, this study did not study the same students for 6 years, which led doubts that if it actually represented the improvement of actual students. These studies focus on school effects of general high school whereas this particular study focuses on school effects of science high school, which is distinctive from previous studies.

III. Method

A. Sampling
This study used data from Kim, Y., et al(2006)'s published by Korean Educational Development Institute in 2006. According to Kim, Y.'s study, 150 general schools and all the science high schools were selected as stratified random sampling, which was 11.34 % of general high schools in Korea. The general high schools were selected from 16 cities and provinces based on size of the region. Also, in Kim, Y., et al.(2006)'s study, principal, head teacher, teacher, students and the students' parents participated in the research. The students were selected from two classes in 2nd grade in each high school, which were randomly assigned. The reason why this study used Kim, Y., et al.'s data is because their study is based on all science high schools, and

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4) Specialized high school includes science high school and foreign language high school.

therefore it provides sufficient information about science high school and its students.

For the sake of analysis, this study is limited its subjects to general high schools in the location that high school equalization policy is applied. The reasons are as follows. First, it enables this study to control the effects that are caused from location of schools. Second, by deleting general high schools that has selection process, this study has controlled bias from selection process. Among 5 different types of survey from Kim. Y, et al.'s study(2006), this study used the survey results from parents and students. Through direct surveys on students, this study examined students' educational activities and life-style. Also, this study was able to figure out parents' supporting activities as well as family background information by surveying parents. This study did not include the response, unless the data included responses from both students and parents. Finally, the sampled students were 2,421 students from general high schools, 281 students from science high school, and the responded schools were total 57 general high schools and 9 science high schools.

B. Variables

1. Student-level Variables
Since this paper sets science achievement scores as school effect, student's science achievement scores is the dependent variable. Independent variables are categorized as input and process variables that are composed of individual and school activities. Input variables are student's gender, mother's schooling years, and household income. Since traditionally girls show lower achievement at science, which is not true in some studies these days(Kim, Y., et al., 2006), it is needed to include gender as a control variable. Parent's schooling years and economic status are both good indicators in many studies on student's achievement(Sung, K., 1997; Kang, et al., 2005; Kim, Y., et al., 2006; Kim, S., 2006; Yim, H., 2006). In the study, mother's schooling years and household income are separately set because

the effects of schooling and economic status are expected different based on previous studies. Household income is the estimate between 2SD to reduce bias caused by outliers.

Individual process variables are student's interests in science, parental support, and mother's parenting style. Student's interests in science represents how much the student is interested in the subject and is increasingly regarded as importance as educational goal and mediator of achievement(OECD, 2001; Yun & Kim, 2004).[5] Because science high school emphasizes on student's talent and interests in science, variable of interests in science is selected as a predictor. Parent's educational support means how much parents give emotional, intellectual, and actual help for their children.[6] Parent's intervention and support are regarded as important indicator for their children's academic success(Lee, J., 1981; Wilson-Jones, 2003), which is especially true of specialized high schools. Mother's parenting style describes how much parents are democratic in parenting, which is expected good predictor on achievement.[7]

School related process variables are teacher morale and class atmosphere. Teacher morale is teacher's enthusiasm and morale in teaching[8] and is regarded as important predictor on student's achievement(Rosenshine & Furst, 1971). According to

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5) Interests in science are measured by the items ① I like to study science, ② I am fully engaged in studying science, ③ science is importance regardless of test scores, ④ I am good at science, ⑤ science is my favorite subject, ⑥ I am fast learner in science.

6) Parent's educational support means ① financial support for private tutoring, ② school visit for career counseling, ③ emphasis on study in house, ④ homework check, ⑤ teaching, ⑥ collecting information on college admission, ⑦ advice on study plan, ⑧ counseling on career, ⑨ test score check, ⑩ schedule check.

7) Mother's democratic parenting are estimated by the items ① mother understands me, ② mother respects and listens carefully my opinion, ③ mother helps me to handle my troubles, ④ my mother has coherency in treating me, etc.

8) Teacher's morale is estimated by student's perception on ① my teacher is willing to do anything, ② my teacher is very enthusiastic, ③ my teacher is very proud of my school.

the previous studies and Michigan State Board of Education, class atmosphere affects students achievement.[9] The studies showed that students got higher scores in the classroom where emphasizes academic success.

2. School-level Variables

School level control variables are location of schools, school mean household income, and school mean mother's schooling years. Location of school are categorized as metropolitan, large cities, and town.[10] School mean mother's schooling years and school mean household income are calculated by a school. School level process variables are school mean teacher morale and school mean class atmosphere. The reason school level variables are set is to analyze how school level variables are displayed differently depending on a school. The statistics and summary of the variables are represented at <Table 1>.

Table 1. Descriptives

	Variable	Number of cases	Mean	SD	Minimum	Maximum	Coding
Student-level	Gender	2,702	0.53	0.5	0	1	Girls 0, Boys 1,
	Mother's schooling year	2,702	12.95	2.17	9	21	Number of schooling years
	Household income	2,702	5.75	0.52	3.4	6.82	Value of natural log of monthly average income(within 2SD)
	Parent's educational supports	2,702	3.17	0.64	1	5	Student's perception, 5 Likert, α =.858

9) Class atmosphere are estimated by the student's perceptions on ① it takes long time for students to be quiet, ② it is hard to focus on studying in my classroom, ③ students in the classroom would not listen to teacher's instruction, ④ it takes long time to begin to study until beginning to study, ⑤ the students in the classroom are noisy, ⑥ the students in the classroom do not focus on studying, ⑦ the students in the classroom do other work. The items are re-coded and higher scores represent academic class atmosphere.

10) Metropolitan means Seoul, Kyunggi, and Inchon. The reason these areas are categorized one area is the students in these areas are similar tendency in getting into the science high school compared with other areas.

	Mother's democratic parenting	2,702	3.55	0.64	1	5	Student's perception, 5 Likert, a =.824
	Interests in science	2,702	2.93	1.11	1	5	Student's perception, 5 Likert, a =.939
	Teacher's morale	2,702	3.36	0.65	1	5	Student's perception, 5 Likert, a =.785
	Class atmosphere	2,702	2.84	0.54	1.29	5	Student's perception, 5 Likert, a =.704
	Science achievement	2,702	50.89	18.53	0	97	Score that represents basic ability and knowledge that can be applied in appropriate situation and purpose
School-level	School type	66	0.14	0.35	0	1	Science high school 1, general high school 0
	School mean mother's schooling year	66	13.07	0.93	11.53	16.38	School mean of mother's schooling years
	School mean household income	66	5.74	0.2	5.18	6.24	School mean of value of natural log of household income
	School location	66	1.97	0.76	1	3	Metropolitan(Seoul, Kyung-Gi, Incheon) 1, large cities 2, small cities 3
	School mean teacher's morale	66	3.37	0.3	2.9	4.21	School mean of teacher's morale
	School mean class atmosphere	66	2.83	0.18	2.38	3.24	School mean of class atmosphere

C. Modeling

In order to answer to research questions, this study established models that include academic achievement test as a dependent variable in order to anticipate science achievement that is influenced by attending to special high schools. During the process of analyzing school effects of science high school, interests in science can be the important explanation variable because science high school is supposed to select science talented students based on purposed of school.

Control variables are divided by background variable and process variable at both student and school level. Student's background variables mean relatively fixed variables, such as

parents' socio-economic level and gender, and process variable represent relatively flexible ones, such as, parent's education supports and relationship between parents and child. According to Kang. S's study(2005), parent's education supports and relationship between parents and child were set as background variables, and however, this study considers this relationship variable as flexible one due to changes in interaction between student and parents, therefore setting it as a process variable. School background variables include average income level at school, average schooling years of mothers at school, and location of school, whereas school process variables include school average of teacher's morale level and average class atmosphere. At both levels of student and school, process levels were added after the background variables were added, therefore it was possible for them to be distinguished and this study was able to explain the effects of process variables alone.

The models in this study can be explained as following. Model I is a basic model which includes neither predictor nor control variables. Among the variance of students' academic achievement, the part which can be explained by individual difference and the part which can be explained by difference in school characteristics, can be analyzed the model I. Model II is a model which only includes school type(a science high school or not), not considering any variables, and therefore this model analyzes the difference in average achievement level. Model III is a model for the analysis of anticipating achievement level after controlling interests in science. Other models are model IV, model V, model VI, model VII, and model VIII, in which student level background variable, student level process variable, school level background variable, school level process variables were added accordingly to each model. <Table 2> summarize the above.

Table 2. Model summary

			I	II	III	IV	V	VI	VII	VIII
Independent variable	School level	School type	×	○	○	○	○	○	○	○
	Student	Interests in science(process)	×	×	○	○	○	○	○	○

	level									
Control variable	Student level	Gender, mother's schooling years, household income(input)	×	×	×	○	○	○	○	○
		Parent's educational supports, mother's democratic parenting(individual process)	×	×	×	×	○	○	○	○
		Teacher morale, class atmosphere(school process)	×	×	×	×	×	○	○	○
	School level	School location, school mean mother's schooling years, school mean household income(input)	×	×	×	×	×	×	○	○
		School mean teacher morale, school mean class atmosphere(school process)	×	×	×	×	×	×	×	○

The models are described as the following equations, and all the independent variables are grand-mean centered.

$Science\ Achievement = \beta_{0j} + \beta_{1j}(\text{interests in science})_{ij} + \beta_{2j}(\text{gender})_{ij} + \beta_{3j}(\text{mother's schooling years}) + \beta_{4j}(\text{household income})_{ij} + \beta_{5j}(\text{parent's education supports})_{ij} + \beta_{6j}(\text{mother's democratic parenting})_{ij} + \beta_{7j}(\text{teacher's morale})_{ij} + \beta_{8j}(\text{class atmosphere})_{ij} + r_{ij}$

$\beta_{0j} = r_{00} + r_{01}(\text{science high school})_{ij} + r_{02}(\text{school mean mother's schooling})_j + r_{03}(\text{school mean household income})_{ij} + r_{04}(\text{school location})_{ij} + r_{05}(\text{school mean teacher's morale})_{ij} + r_{06}(\text{school mean class atmosphere})_{ij} + u_{0j}$

$\beta_{1j} = r_{10}$

$\cdots$

$\beta_{8j} = r_{80}$.

IV. Results

The results are displayed in <Table 3> and <Table 4>. The model I, shows that variance within school is 69.23% of a variance as a whole, and variance between schools is approximately 30.77% of the whole variance. It represents that students' achievement can be different depending on schools by 30.77%. Model II is the one that explains difference in science

achievement depending on school type. It is noticeable that science high school has a higher score than a general high school by 26.98 points, and initial scores in science show a big difference between two schools. In model II, it is clear that variance has been remarkably decreased compared to model I. When looking at the difference in variance, the differences in achievement between schools explain approximately 73.50% of the difference. Thus, going to science high school has a huge influence in differences in science achievement. However, since this model has only focused in a variable of science high school not considering other variables at all, the effect of science high school must be overestimated at this point.

Model III is the model to find out how much the interests in science can explain the level of science achievement regardless of science high school. Compared to model II, interest in science explains about 17.33% of achievement between students. It is also difficult to say that decrease in variance in model III can be solely explained by the effects of interests in science because model III does not consider other student's individual variables as well.

Looking at the model IV, students in science high school earn about 18.15 point higher score than those students in general high schools, when hypothesizing that student's individual background variables, such as gender, mother's schooling year, and income level, are the same. Compared to variance at student level in model III, the variance in student level has rarely decreased, which means that student's individual background variable explains only about 0.74% of variance at student level. When comparing model IV to model V and model VI, variance at student level rarely decreased, and this illustrates that added student's process variables in model V and model VI do not explain much of student's science achievement.

Table 3. Variables affecting science achievement at student and school level(I)

	variable name	Model I	Model II	Model III	Model IV
student	intercept	51.92(1.36)***	51.98(0.76)***	51.66(0.72)***	51.59(0.70)***

level					
	interests in science			$6.43(0.27)^{***}$	$6.38(0.27)^{***}$
	gender				$-0.25(0.88)$
	schooling years(m)				$0.53(0.15)^{**}$
	household income				$1.37(0.61)^{*}$
	educational support(m)				
	democratic paranting(m)				
	teacher morale				
	class atmosphere				
school level	science school		$26.98(2.30)^{***}$	$19.45(2.20)^{***}$	$18.15(2.16)^{***}$
	school mean schooling years				
	school mean household income				
	school location				
	school mean teacher morale				
	school mean class atmosphere				
	between school variance	115.50^{***}	30.61^{***}	28.36^{***}	26.18^{***}
	within school variance	259.90	260.04	214.96	213.38

$\sim \, < .10, \; * \, < .05, \; ** \, < .01, \; *** \, < .001$

Model VI includes all of predictor and control variables at student level assuming that everything holds the same for background variable and process variable at individual level. Thus, even if all the other conditions are same, there is still a difference in score by 18.09 points approximately between the students in science high schools and those in general high schools. In other words, students who attend science high school get 18 points higher score than those students who go to general high schools, even with consideration of every controlled variable at student level. If looking at the coefficients, interests in science is the highest predictor in science achievement. Interests in science had a coefficient value of 6.36 approximately even after consideration of all students' background variable and process variable. This illustrates that if student's interests in science have 1 higher SD, the grade of the student get about 6.36 higher score. Among the student's family background variables, the significant variables are mother's schooling years and income level. The student with mother who has graduated from college showed about 2.21 higher score in science course than one with high school graduated mother. If the household earn 1,000,000

Korean won more than the average household, the student get approximately 0.75 higher. Among the student's school process variables, class atmosphere is the variable that has a significantly positive effect. As there is 1 SD increase in class atmosphere, student's score is about 1.37 point increased.

Model VII and model VIII represent the results including school level background and process variables. When model VII includes school level background variable, the added variables about 29.68% of total variance compared to model VI. Comparing model VIII with model VII, school level process variables explain about 3.68% of the total variance. Therefore it can be said that background variable explains more than process variable at school level. It is can be seen that regression coefficient of science high school is remarkably decreased, when model VII includes school level variables. From model VII and model VIII purer effects of science high school deleting out-of-school effects can be calculated.

Model VIII is the final model theoretically set that controls all variables both student and school level. Even at model VIII, science high school still has superiority in science achievement. It says that, despite of the same family background variable, same process variable, and the same location of the school, students in science high school get about 7.33 higher score than those who do not. Among the school level variables, school mean income and school location have a positive relationship with student's science score. Students whose household earns about 1,000,000 Korean won more than average school income level, show about 22.94 higher in science. If schools are located in small to middle cities, students mark 5.88 higher score than those in suburban area. However, there was no significant variable among process variables at school level.

Table 4. Variables affecting science achievement at student and school level(II)

	variable name	Model V	Model VI	Model VII	Model VIII
student level	intercept	51.59(0.70)***	51.59(0.70)***	51.55(0.61)***	51.53(0.60)***
	interests in science	6.37(0.27)***	6.36(0.27)***	6.38(0.27)***	6.37(0.27)***
	gender	-0.19(0.89)	-0.45(0.90)	-0.87(0.86)	-0.59(0.88)

	schooling years(m)	0.54(0.15)**	0.55(0.15)***	0.53(0.15)**	0.53(0.15)**
	household income	1.39(0.62)*	1.41(0.62)*	1.23(0.63)~	1.22(0.631)**
	educational support(m)	-0.08(0.48)	-0.14(0.49)	-0.13(0.49)	-0.14(0.49)
	democratic paranting(m)	0.42(0.46)	0.48(0.46)	0.46(0.46)	0.47(0.46)
	teacher morale		1.41(0.62)	0.51(0.49)	0.42(0.49)
	class atmosphere		1.37(0.57)*	1.35(0.57)*	1.47(0.57)
school level	science school	18.05(2.16)***	18.09(2.17)***	10.31(2.77)**	7.33(3.31)**
	school mean schooling years			0.35(1.23)	0.53(1.22)
	school mean household income			16.43(5.10)**	16.50(5.06)**
	school location			2.73(0.87)**	2.94(0.87)**
	school mean teacher morale				2.62(3.18)
	school mean class atmosphere				-5.07(3.98)
	between school variance	26.13***	26.18***	18.41***	17.73***
	within school variance	213.48	213.14	213.15	213.13

~ < .10, * < .05, ** < .01, *** < .001

It is summarized as follows. First, it is found that students in science high school get higher scores in science than those in general high school even after considering related variables. Secondly, interests in science positively predict achievement regardless of enrollments in science high school. Thirdly, mother's schooling years and household income at student level, and mean household income and school location at school level are influence students' achievement. Especially, household income has positively affect student's achievement at both student and school level. It indicates that schools with higher school mean income show higher level of academic achievement. Moreover, even within the school, students with higher household income show higher achievement than those with lower household income.

V. Discussion

It is possible to discuss a few agendas based on the results of this study. First, does science high school offer an appropriate education that fits the original purpose? It is necessary to know the original purpose of science high school. Science high schools

were established in order to supplement school equalization policy by discovering students who are talented and interested in science, and to develop their creativity(Suh, H., 2006:10). The results of this study says 'yes'. According to the study results, science high school provides differentiated science education from general high schools, if looking at the current students' high science achievement level.

Second question would be whether science high school students have higher academic achievement level than those students from general high school even after controlling school level background variables? In other words, this study imposes a question if science high school still has its internal effects even after controlling effects related to school environment, such as its location. This question is started by inquiring what are considered as school effects, as previously mentioned above. It is possible to separate the effects of science high school based on the discussion of whether to include effects even from out-of-school, such as its location and socio-economic effects, or just to include the effects that are only caused by activities within the school itself. According to Raudenbush & Willm's way of typology, the first effects are called as Type A school effects, and the second effects are called as Type B school effects(1995, 309-310). Model VII and model VIII in this study show school effects of Type B. According to the study result, even after considering the effects that might be caused from school's background characteristics, science high school still showed higher achievement scores than general high schools. This illustrates the effects of differentiated education at science high school. Thus, science high school's curriculum that focuses on science-oriented education with higher number of science classes and after school classes seem to contribute science high school students to get an education for excellence and higher achievement. Therefore, the results from this study show that education in science high school has a positive influence on science achievement even after controlling school's contextual effects.

Thirdly, among science high school's educational activities,

which activity contributes to improving achievement? As mentioned above, research on school effect gradually show more interests in Type B school effects that are focused on internal activities within a school. In addition, by shifting from input-output model to input-process-output model, it is possible to study which activities in school actually contribute to school effects. Therefore, this study includes process variables that are expected to have an actual influence on the schools based on the previous studies and they are teacher's morale and class atmosphere. The previous studies show these variables have positive effects on academic achievement(Kim, Y., et al., 2006: 212-213; Sung, K. 1997: 207). However, in this particular study, these process variables do not bring significant differences. It might be caused by the difficulties in measuring psychological variables. Thus, it is necessary to plan out the study precisely from the starting point of data collection in order to find out the influences of the school activities.

Fourthly, what are the background variables at both student and school level that affect student's achievement? In this study, it is found that mother's schooling years and household income at student level, and school mean household income and school location at school level affect student's achievement. This study shows consistent result with Kim, S.'s study(2006, 98-99) regarding effects of mother's schooling years. As far as household income, this study is not consistent with Kim, Y., et al.'s study(2006) that shows non-significant coefficient of household income. This inconsistency might be caused by different setting of control variables from this study. School location variables in common demonstrate significance in all the studies by Sung, K.(1997), Kim, S.(2006), and Kim, Y., et al.(2006). One thing to be mentioned related with the effects of background variables is that parent's schooling years and income level are constantly found out influential on student's achievement. It tells that more political efforts to guarantee educational equity are needed.

This study starts from recent doubts if science high school is deteriorated as a short cut to the top-ranked universities. By

considering that the original purpose of science high school is to supplement gifted youth in science, this study uses science achievement as an evidence to prove its effectiveness. According to the results of this study, science high school shows higher academic achievement than general high schools because the school selects talented students with more interests in science. Therefore, these results diminish the initial doubts on science high schools, in terms of realizing the purpose of education for excellence in science. Thus, science high schools can be concluded that it is appropriate for its initial purpose.

However, it is questionable whether science high school also has its school effects in other subject as well, as expected. This question suggests other following studies to be conducted in order to find out about the effects of science high school based on academic achievement in other subjects. In addition, this study does not show if the higher scores of science high school are caused by school activities because of the limitations of the data sources. In the further studies, it is needed to control the previous academic scores to look into the pure effects of science high school. Another suggestion is that it is necessary to conduct a follow-up study including classroom activities to improve actual instruction in the classroom.

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