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Shock and Imbalance of the System: A System Dynamics Approach for the Effects of Lowered Retirement Age of Teachers on education system

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Abstract

Since the economic crisis in 1997, the Korean government has implemented a number of reforms in order to eliminate inefficiencies in both private and public sectors. One of the reforms made in the public sector was to lower the retirement age of teachers from the original age of 65 to that age 62. The ultimate aim of this compulsory policy was to improve the quality level of education by hiring many young teachers instead of senior teachers. It was made based on the calculation that by lowering the retirement age by three years, the government can hire three young teachers with the saved wages. However, this policy has brought an unexpected result; the imbalance between the supply and demand for teachers has become a much more serious problem in Korea's elementary education system. The purpose of this study is largely twofold; First of all, it aims to identify the scope of imbalances occurred in the supply-demand system of elementary school teachers in a region of the nation, and also to find out why such imbalance occurred. Secondly, the purpose of this study is to experiment with feasible policy alternatives and their effects on the system and to suggest some resolutions on the imbalance.

It turns out that the government's sudden move to reduce the retirement age will eventually cause a serious imbalance between supply and demand for teachers. These imbalances are expected to persist as long as there are no efforts to improve the teacher supply and demand system in disadvantaged regions with worse educational conditions. The Simulation results of the policy experiment shows that the problems may not have been as serious had the government implemented proper policies in a more timely manner; the government should have predicted a serious shortage of teachers and increased the number of students for universities of education, and also tried to increase the apply rate of teacher-recruitment test in smaller regions by improving wages and working conditions.

Keyword: lowering of retirement age, Imbalance, education system, teacher supply and demand

I. Introduction

Given that one of the most urgent tasks in implementing educational renovation is to change and improve educational policies for teachers, it is crucial to be able to make accurate predictions on possible changes in supply and demand for teachers when making relevant policies and also to examine the feasibility of the new policies. The reason is that such policies on the supply and demand for teachers, which are designed to secure the proper number of qualified teachers, are bound to have major impacts on such factors as the number of students assigned to a teacher, working hours, and the amount of task. These factors, ultimately, work as important elements determining the quality of a nation's education system. However, as the Korean economy collapsed in 1997 and asked for a bailout from the International Monetary Fund, the Korea Ministry of Education lowered the teacher's retirement age from the original age of 65 to that of 62, in order to cut budgets, balance between retirement age of teachers and other government officials, resolve the problems of unhired pre-teachers, reinvigorate teachers' societies, and narrow the generation gap between teachers and students. This policy was implemented as part of the government's reform efforts, but it has led to a massive shortage of elementary school teachers. In this regard, it is urgent to work out basic plans and policies on supply and demand for teachers, with long-term perspectives.

In the past, problems regarding the supply of teachers occurred mainly because of miscalculations of the number of needed teachers or entrants in teacher-training institutions. Currently, however, a large number of teachers are leaving their workplaces because of shortened retirement age and insecure retirement allowances and pensions. It is predicted that Korea's elementary education system might collapse if the government does not make efforts to come up with effective policy countermeasures. Such concerns are being raised by the people not only in the educational field but also in society as a whole.

Against this backdrop, this study aims to analyze the negative ripple effects of the shortened retirement age-a major culprit behind the failed teacher supply policy- and also to figure out what has caused such negative effects. To this end, we have selected the Chung-buk Province as the model region and set up a model of its elementary schoolteacher supply system and implemented simulation tests, utilizing the system dynamics technologies.

In particular, this study is an attempt to find out the structural reason of the imbalance, focusing on the how, and why of long-term imbalances in the teacher supply and demand system. In addition, this study will make predictions on the scope of imbalances of elementary school teachers on the assumption that the current status will be maintained. This study also aims to predict whether a proper numbers of teachers can be maintained down the road, by suggesting and testing feasible policy alternatives.

We also examined if such educational alternatives (aiming at improving the quality of education) as reducing the size of a class can be implemented successfully with the current teacher supply and demand conditions in the Chung-buk Province.

II. System thinking about Teacher Supply and Demand in the educational system

1. Determinants and Imbalances of Teacher Supply and Demand

The size for supply and demand of teachers is determined by various factors in and outside of the educational field. In other words, inside factors are affected by a variety of outside factors, and the size of supply and demand for teachers is determined by interaction of these factors (Kim, Heung-sik, 1987). In this study, we will take a look at the major factors that affect the size of supply and demand for teachers.

First of all, factors determining the numbers of needed teachers can largely be divided into two categories; first, inside factors such as enrollment children rate, teacher-to- student ratio, and retirement rate of teachers; second, outside factors such as the changing population, birth rate, educational budget-to-GNP ratio, and wage and employment rates of other jobs.

Next, the amount of teacher supply is affected by government policies more than that of teacher demand. This, in large part, is because mainly the number of education university graduates determines the size of teacher supply in teacher-training systems and qualifying systems. To sum it up, it can be said that the amount of teachers supplied is determined by the demand for teachers (which is also determined by various factors) and the types of policies designed to meet those demands.

Admittedly, supply and demand for teachers is best to strike a balance. In reality, however, the current teacher supply system is suffering from an imbalance, due to various factors, both inside and outside of the educational field. In particular, the retirement rate of teachers has increased sharply because the educational budget was slashed and the retirement age of teachers was lowered as part of the government's reform efforts aiming at recovering from the 1997 economic crisis. As a result, the imbalance has worsened, and people are raising concerns that if this trend goes unchecked, such serious side effects as class cancellations and unqualified teachers may emerge.

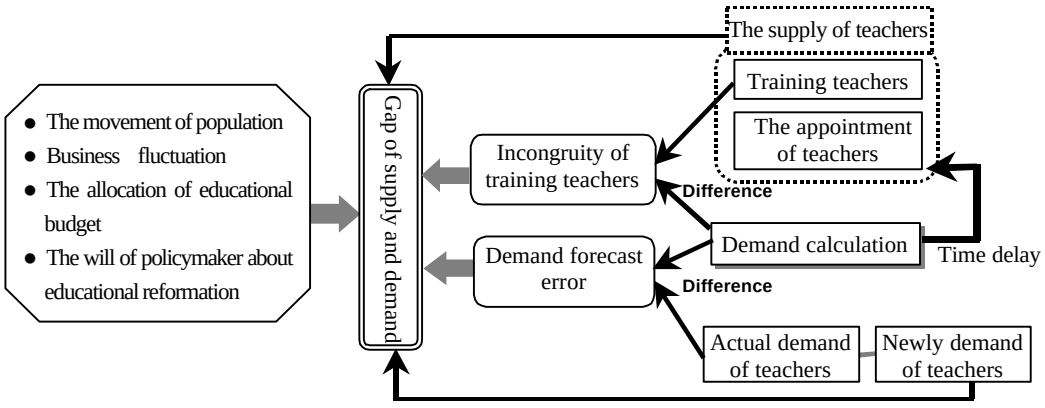

Figure 1. The structural reasons for teacher supply imbalance

Even if the amount of future supply and demand for teachers is well-calculated, temporary imbalances between supply and demand are unavoidable because it takes quite a long time before supply can meet the increased demand, depending on the conditions, both inside and outside of the education system. In particular, such imbalances can also be caused by outside factors, such as changes in the transfer rate of teachers (caused by population moves and changes in the labor market following economic booms and busts)(Kim, Sun-chong, 1988).

However, according to our research, it appears that the supply-demand imbalance in the Chung-buk and the Chun-buk Provinces are due largely to a failure to implement relevant policies and the inflexible teacher supply and demand system, which has caused a temporary shortage of teachers after the economic crisis and the subsequent lowering of the retirement age of teachers.

2. Dynamics of Teacher Supply and Demand

To date, the Korean teacher supply policies have, in effect, never succeeded (Shin, Hyun-sik, 1999). The major reason for the policy failures can be attributed to the absence of policymakers' system thinking.

The system thinking is a framework of thinking, which emphasizes not only the role of subparts but also understanding of the whole structure. It also puts more emphasis on interaction among the subparts (Kim, Doa-hun, 1999). Today, society has become much more complicated than before, and interaction among the subsystems has increased. In this regard, the system thinking enables people to better understand today's complicated social phenomena and social ills. Since it enhances people's understanding of the fundamental reasons, causal relations and structure of social problems. However, educational policymakers have lacked such system thinking in establishing teacher supply policies and consequently, 1) they have implemented ill-planned teacher supply policies with only short-term views. 2) Rather than try to get to the bottom of the problems and come up with countermeasures, they have implemented inconsistent teacher supply policies. 3) Their policies have failed to be integrated and have been separated from relevant policies regarding supply and demand for teachers. They have implemented one-time policies and stopgap measures, whose functions are no other than to report the status of supply and demand for teachers. 4) They have yet to established a systematic teacher supply model that takes into account interactions among various determinants of supply and demand. Generally speaking, their policies have only been cosmetic measures. 5) They have taken into account only inside factors in calculating the size of demands for teachers. As they have focused only on separate subparts and failed to see the educational system as a whole, they couldn't respond to the changing educational circumstances and the subsequent changes in supply and demand for teachers.

In order to resolve these problems, we have to adopt the system thinking in establishing teacher supply policies. Furthermore, with the system thinking in mind, we should put more efforts to set up a long-term fundamental teacher supply plan, which is based on profound knowledge and better understanding of the teacher supply-demand system and its structure.

We need to adopt system dynamics in developing teacher supply policies. The reasons are largely threefold;

First, the supply of teachers should be sustained over a long period, in which teachers can be provided consistently whenever they are needed in schools. Although supply plans might be affected by changes in the structure of the workforces in the labor market (in this case, schools), there certainly exists a basic framework or structure of workforce supplies (Shin, Hyun-sik, 1999). Unlike econometrics, which attributes changes in a system to changes in parameters related to particular variables, the system dynamics attributes changes in a system to the general structure of the system (Kim, Doa-hun, 1999). Therefore, we can utilize the system dynamics in establishing teacher supply policies to find out a feedback structure that exists between variables determining the success or failure of such policies. Furthermore, we can find out the reasons of success or failure of a policy and, if necessary, work out another policy alternative.

Secondly, in order to establish an effective teacher supply plan, it is necessary to calculate the size of demands for teachers and at the same time, to figure out what has caused the shortage of teachers. Not only that, the teacher supply plan should contain a quantitative index indicating the proper number of qualified teachers. It is also closely related with a problem faced by the relevant authority; that is, how to operate a teacher-nurturing system effectively so as to meet the changing demands for teachers in the long run (Shin, Hyun-sik, 1999). Until recently, however, the teacher supply-demand policies have taken into account only the inside factors in identifying the demands for teachers, and they have only focused on determining the size of teacher supply based on their own calculation. As a result, they have failed to consider the interaction and interrelation between such factors as the effects of supplies of teachers on demands for teachers, and vice versa (as illustrated in the figure 2). In this regard, when establishing teacher supply-demand policies, it is necessary to utilize the system dynamics, which enables us to expand the scope of researches to include not only inside but also outside factors, and also to consider the interactions between supply and demand in determining the size of teachers, based on predictions on demands for teachers.

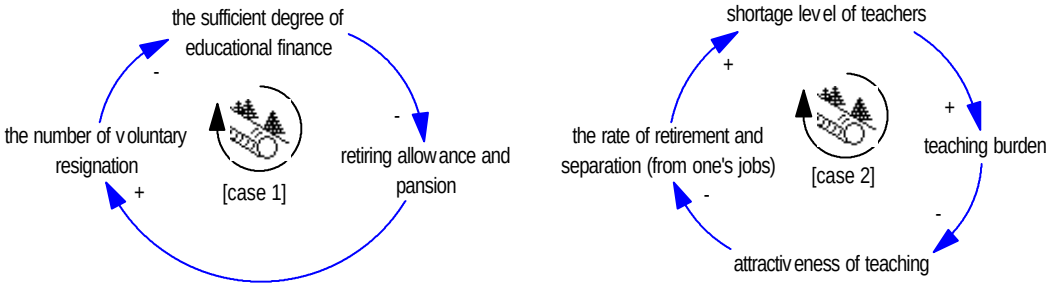

Figure 2. The feedback loops of supply and demand for teacher

Third, in order to provide qualified teachers whenever necessary, it is important to develop a proven supply-demand model, based on enough information and data on teacher supply and demand. The system dynamics take into account the circulative causal relations and feedback structures, identifies given problems, maps out the causal relations, develops a map that reflects the interactions between variables, and finally, establishes a model designed to resolve the problems. By conducting simulation tests of the completed model on a computer, we can identify the fundamental reasons for current problems and make predictions on the results of alternatives. In this regard, System Dynamics model can be of help in policymaking processes and ultimately, enable us to predict the success of the policies. Therefore, if we adopt the system dynamics in setting up an accurate and updated supply and demand model, we will be able to identify the fundamental reasons behind the policy failures and wipe out the supply-demand imbalances by making accurate predictions on the future supply and demand for teachers, based on the results of the computer simulation tests.

III. Simulation Modeling and Policy Experimental Designs

1. Problem definition: shock and impact of the lowering of the retirement age

It is a general consensus that the economic crisis and the lowering of the retirement age had much effect on the imbalances between the entire supply and demand for elementary schoolteachers in Korea. Regionally, however, the problem is all the more serious; In some regions, the elementary education system is showing signs of a breakdown. In the case of elementary schools in the Chun-buk Province, the object of our research, the shortage of teachers is already very serious. As illustrated in <table 1>, about 1000 teachers (1/5 of the entire teachers) have chosen honorary retirement or early retirement from 1999 to 2000 because of the lowered retirement age.

<Table 1> the number of retirement and voluntary retirement owing to adjustment of retirement age

	1999	2000	Total
Retirement by age limit	347	49	396
Voluntary retirement	456	147	603
Total	803	196	999

The aim of the lowering of the retirement age was to hire more teachers with lower spending on wages. In fact, the amount of the salary for that of one senior teacher is equivalent to that of three young teachers. However, the current teacher supply system does not have enough teachers. Consequently, retirement age lowering resulted in a temporary shortage of teacher, and many people are expressing concerns that the problem won't be resolved soon. Indeed, the Chung-buk Province has tried to hire 400-500 new teachers annually since 1999, when the retirement age was lowered, in order to soften the teacher shortage problem (as illustrated in <Table 2> and <Table 3>). However, since less than 30 % of

pre-teachers applied for the test, it is difficult to provide enough teachers to the elementary schools in the region.

The reason for such a low figure is that the number of graduates from the region' s education universities was only about 350, and a majority of those graduates chose to apply for tests in Seoul and other major cities, where conditions are better than the Chung-buk Province. It means that other smaller regions are suffering from the same problems and that graduates stand better chances to pass the exam when they take a test in smaller regions. What this implies is that the problem of teacher supply and demand system in Korea is not just a problem of a particular region, but is spreading to the entire nation and causing a vicious circle of a failed teacher supply and demand system.

<Table 2> The number of invitation and applicant by year (elementary school of Chung-buk province)

	1998	1999	2000	2001
The number of invitation	260	400	350	500
The number of applicant	280	228	117	138
(the rate of applicant)	(107.69%)	(57.0%)	(33.43%)	(28.0%)
The number of successful applicant	260	226	117	138
The rate of successful applicant	92.9%	99.1%	100%	100%

<Table 3> the school from which applicant graduated (elementary school of Chung-buk province)

	Invitation numbers	applicant numbers	the school from which applicant graduated				
2001	500	138	Chongju Univ. of Education	Korea Univ. of Education	Chunchon Univ. of Education	Taekyo Univ. of Education	The others
			119	9	7	1	2

In this respect, if this trend goes unchecked, it is expected that maintaining the current level of elementary school education in the Chung-buk province (table 4) will be difficult. The number of students in the region has consistently increased since 1998 to reach 124,176 in 2000, while that of teachers has decreased sharply from 5,166 in 1998 to 4,894 in 2000. With the current pace, the Ministry of Education's plan to improve the quality of elementary education by reducing the number of students assigned to a teacher to the OECD level will be difficult to achieve. In this regard, it can be said that the ministry's policies has failed to reap the desired results because its long-term policy objects should be abandoned due to systemic failures in the short-term teacher supply policies.

<Table 4> The trend of schools, classes, students and teachers (elementary school of Chung-buk province)

	1997	1998	1999	2000
the number of school	274	272	257	247
the number of student	118,224	119,409	121,976	124,176
the number of class	3,761	3,865	3,902	3,878
the number of teacher	5,095	5,166	4,914	4,894

2. Causal loop Diagram and Simulation Modeling

Figure 3 illustrates a representative negative feedback loop of the elementary schoolteacher supply and demand system. According to the picture, the imbalance between teacher supply and demand will be lessened over time, and the proper number of teachers will be maintained- on the assumption that there are no limitations on the number of newly recruited teachers. In other words, when there are demands for teachers, we can meet the demands by increasing the number of newly recruited teachers and thus increase the total number of teachers.

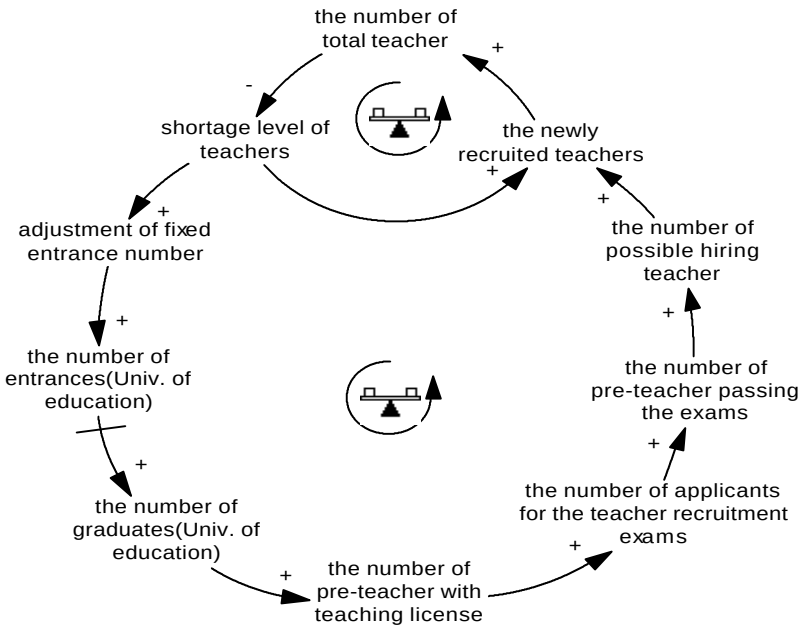

Figure 3. Negative feedback loop of the elementary schoolteacher supply and demand system

In addition, when there are huge demands for teachers, the government can increase the number of students in 11 education universities, and thus bring up the number of education university entrants and graduates. An increase in the number of education university graduates means an increase in that of prospective elementary schoolteachers with teaching licenses. And this, in turn, will lead to a rise in the proportion of pre-teachers and also the number of license-holding applicants for the teacher recruitment exams. And in the long run, it will increase the number of eligible pre-teachers, boosting the possibilities to resolve the shortages of elementary schoolteachers by hiring new ones.

Nevertheless, given that it takes at least 4 years for an education university student to acquire a teaching license, it will also take quite a long time to actually bring up the number of pre-teachers and therefore strike a balance between supply and demand for new teachers.

Next, the feedback structure in Figure 4 is a positive self-reinforcing feedback loops, meaning that the

current pace of changes will be accelerated (Kim, Dong-whan, 2000). If the total number of teachers increases, the number of students assigned to a teacher will decrease, and so will the teaching hours and the amount of task for a teacher. As a result, incumbent teachers' satisfaction level of their jobs will be raised, and this will eventually lead to a decrease in the number of retirees, resulting in an increase in the total number of teachers. Teachers' rising job satisfaction level can bring up the total number of teachers in other ways, too; it will make more teaching license holders actually want to be teachers. In this case, the government can recruit more teachers, as more students will apply for recruitment tests and thus raise the number of eligible pre-teachers.

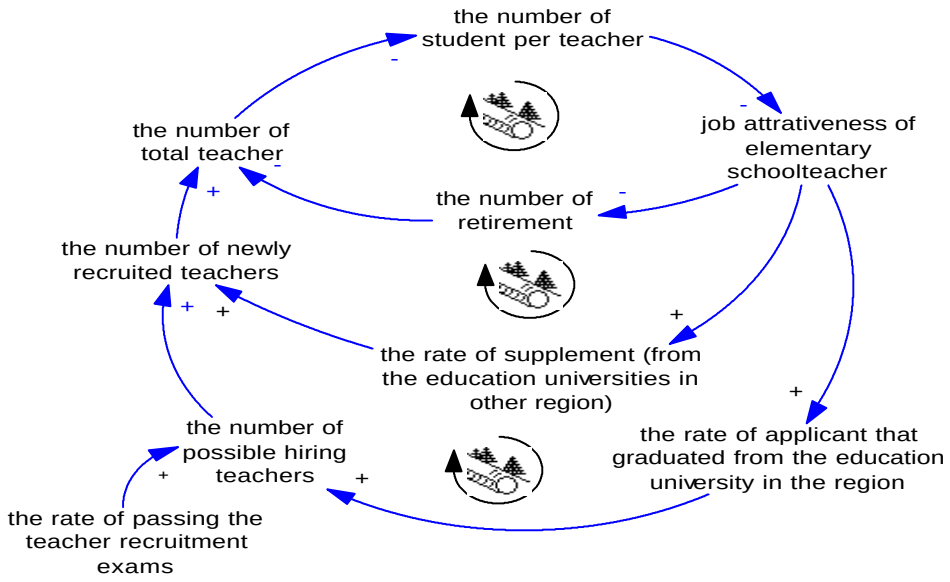

Figure 4. Positive feedback loop of the elementary schoolteacher supply and demand system

Conversely, if the total number of teachers decreases, the number of students assigned to a teacher will increase, and it will eventually lead to an increase in class hours for a teacher, thus lowering teachers' satisfaction level of their jobs. As explained above, a positive feedback loop is either to infinitely increase or to decrease. Therefore, we can find the reason of the continuing instability of the teacher supply and demand system in that the self-reinforcing attribute of such a positive feedback loop dominates the whole feedback loop.

Figure 5 represents the entire causal map of the teacher supply and demand system, which includes the self-balancing negative feedback structure and self-reinforcing positive feedback structure. According to this map, the lowering of retirement age is one of the major factors that sent a temporary shock to the system and brought about a serious discrepancy between teacher supply and demand and also an imbalance of the system.

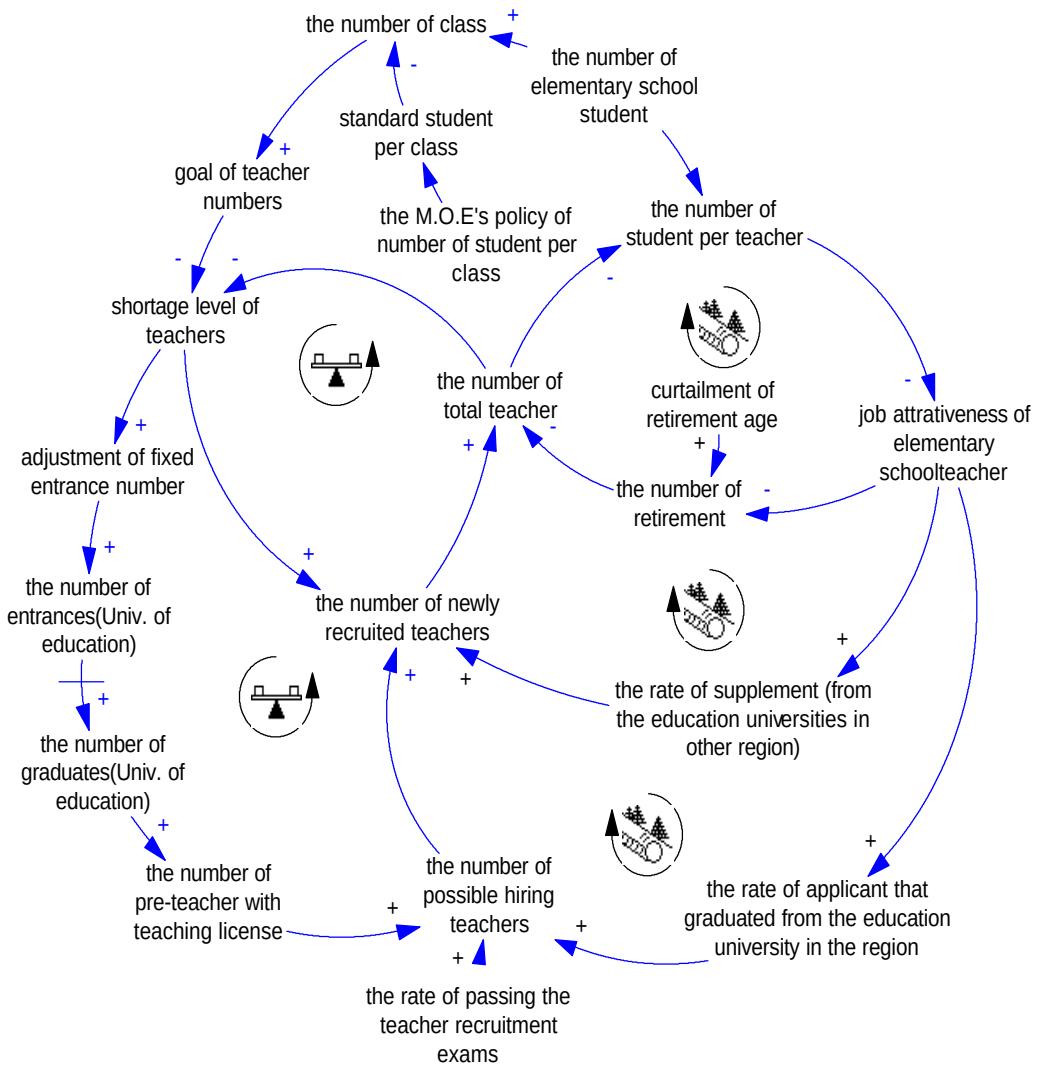

Figure 5. The entire causal map of the teacher supply-demand system

Next, figure 6 is a simulation model that has transformed the map into a stock/flow diagram in order to examine the flexibility of the teacher supply system in the North Chung-buk region. The most important level variables are the total number of students, teachers, and pre-teachers (graduates from Chongju University of Education) in the region. Among the three variables, the number of total teachers will decrease when there are many retirees after lowering the retirement age, and will increase when the number of newly recruited teachers goes up.

number_of_total_teacher(t) = number_of_total_teacher(t - dt) + (newly_recruited_teacher - retirement - retirement_by_age_limit) * dt

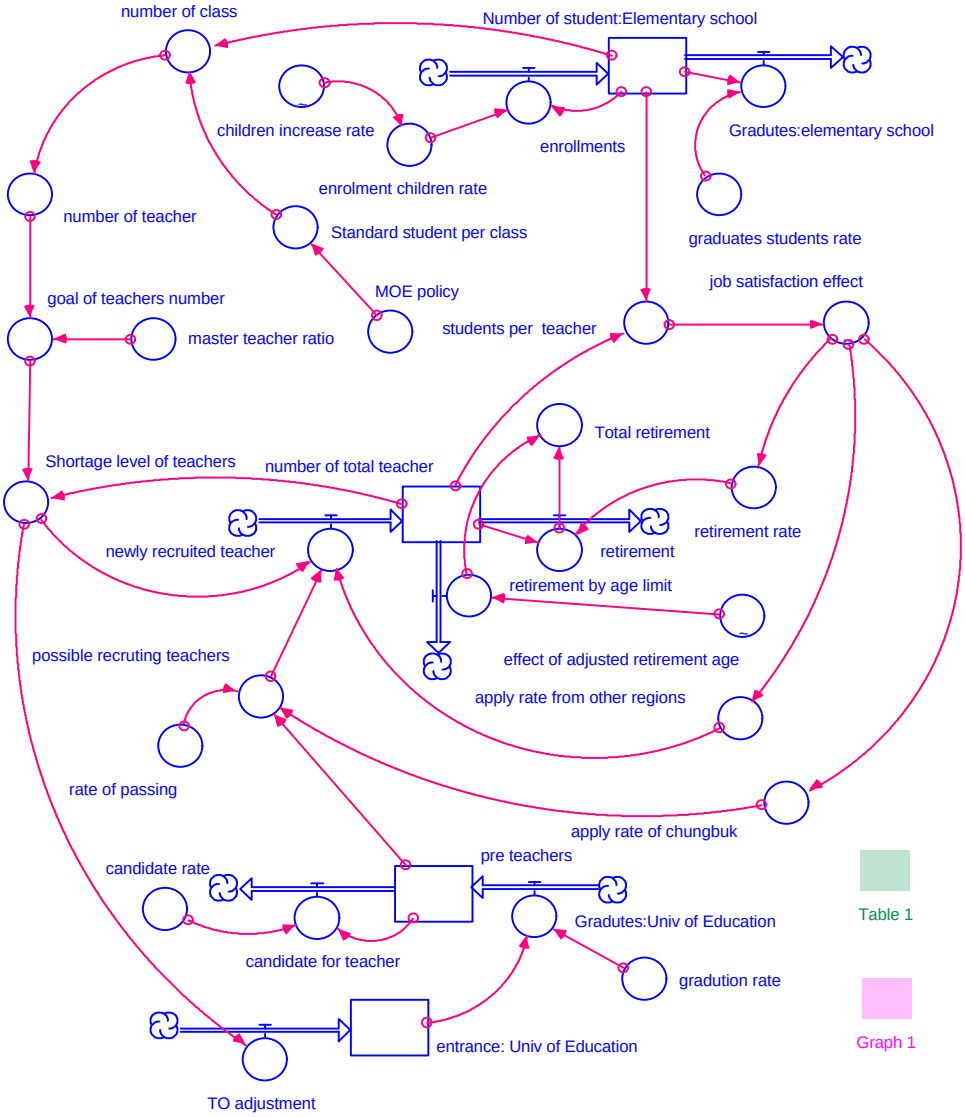

Figure 6. Stock/flow diagram for dynamic analysis of the teacher supply and demand system

The number of newly recruited teachers is determined by the shortage level of teachers, which is calculated by distracting the current number of total teachers from that of needed teachers. One thing to note here is that it is difficult to resolve the shortage of teachers solely by this calculation. We have to take into account other factors such as the number of pre-teachers (graduates from the education universities in the region), apply rate of the Chung-buk and other regions. Also, the calculation is made on the assumption that there will be a one-year period before the actual recruitment takes place, because of the shortage level calculation process and recruiting procedures.

newly_recruited_teacher = DELAY(IF(Shortage_level_of_teachers>=possible_recruting_teachers) THEN possible_recruting_teachers+Shortage_level_of_teachers*apply_rate_from_other_regions ELSE Shortage_level_of_teachers, 1)

The total number of elementary school students in the region will decrease by the number of elementary school graduates and will increase when the enrollment rate goes up, which is affected by the birth rate.

Number_of_student:Elementary_school(t) = Number_of_student:Elementary_school(t - dt) + (enrollments - Gradutes:elementary_school) * dt

Next, the number of pre-teachers decreases by the number of candidates for teachers, which increases by the number of education university graduates in the Chung-buk province. In addition, in policy experiment model 2 and 4, it is predicted that it will take 4 years before the increase in education university entrants brings positive effects to the teacher supply system.

pre_teachers(t) = pre_teachers(t - dt) + (Gradutes:Univ_of_Education - candidate_for_teacher) * dt

3. Focuses of the Analysis and the Policy Experimental Designs

This study is aimed at analyzing the problems of the lowering of the retirement age and the teacher supply system, with its primary focus on the imbalances in the system. For our research, we have selected the Chung-buk region as the object of our study. Another purpose of this study is to criticize the Education Ministry's decision to lower the retirement age of teachers, which was made without preparing policy alternatives and conducting enough experiments. This should be considered as a failed policy given that an imbalance in the teacher supply and demand system will have negative effects on school education and won't readily be resolved under the current teacher supply and demand system.

The main focus of this study, which is designed to analyze the imbalances in Chung-buk province teacher supply system (using system dynamics simulation techniques) is largely threefold; First, what will be the magnitude of imbalances in the system, in case the retirement age is lowered? Second, what causes the imbalances in the teacher supply and demand system? Third, how long will the imbalances in the teacher supply and demand system persist, and can it possibly be resolved? Forth, will the policy alternatives suggested in this study prove to be effective in resolving the shortages of teachers? If so, how do they work and when can they eliminate such shortages? Fifth, given the current teacher supply and demand system, is it possible to provide the appropriate number of teachers and improve the quality of education to the level of advanced nations? If not, what could be suggested as feasible policies, and will they really work?

<Table 5> focus of the analysis and the policy experiment design

	basic model	policy experiment model 1	policy experiment model 2	policy experiment model 3	policy experiment model 4
Suggested Policy	Make predictions on the current conditions	- Increase the apply rate within the region (45->60%) - Increase the apply rate from other regions (5->20%)	- Contents in policy experiment model 1 - Increase the number of education university entrants by 20%	- Decrease the number of students-per-class(31->25) in order to improve the quality of education	- policy experiment model 3 - policy experiment model 1 + policy experiment model 2
Focus of the Analysis	1. What will be the magnitude of imbalances in the system, in case the retirement age is lowered? 2. What causes the imbalances in the teacher supply and demand system? 3. How long will the imbalances in the teacher supply and demand system persist, and can it possibly be resolved? 4. Will the policy alternatives suggested in this study prove to be effective in resolving the shortages of teachers? If so, how do they work and when can they eliminate such shortages? 5. Given the current teacher supply and demand system, is it possible to provide the appropriate number of teachers and improve the quality of education to the level of advanced nations? If not, what could be suggested as feasible policies, and will they really work?				

The contents of this study's simulation models and policy experiment design are illustrated in the graph below. The basic model is made based on the current condition of education in the Chung-buk region. The policy experiment models are designed to work out policies on the assumption that the fundamental reason of the imbalances in the teacher supply and demand system lies in the system itself, which cannot meet the increased demands for teachers (caused by a temporary increase in the number of retirees). In particular, compared to other regions, the Chung-buk Province shows a relatively low number of education university graduates and also a remarkably low application rate of students from other regions. As a result, the region is suffering from a serious shortage of teachers. If the shortage is removed, so will other related problems. The policy experiment models in this study are made on these assumptions. The prediction that an increase in the application rate of pre-teachers from other regions will increase is made on the presumption that making investments in improving the condition of education in the region - particularly, the current bad working condition (resulting from the shortages of teachers)- will contribute to increasing teachers' satisfaction level of their jobs and thus bring up the transfer and application rate in the region.

In policy experiment model 1, we increased the current apply rate of 45% to 60%, while increasing that of pre-teachers from other regions from the current 5% to 20%. In policy experiment model 2, we expanded the number of education university entrants shown in model 1 by 20%. Next, policy experiment model 3 is made on the assumption that the Ministry of Education will take measures to reduce the number of students-per-class from the current level of 31 to 25, in order to improve the quality of education to the level of advanced nations. In policy experiment model 4, we applied the policy alternatives suggested in model 1 and 2 to the circumstances in model 3, in order to devise measures to resolve the problems related to teacher shortages.

IV. Simulation Results and policy Implications

1. Simulation Results of the basic model

In the basic model, we attempted to figure out how the lowering of the retirement age affected the current teacher supply and demand system in the Chung-buk region, and we also made predictions on the future development of the effects in the system.

As shown in figure 7, the result of the simulation tests found that the supply system of elementary schoolteachers is suffering from a prolonged shortage of teachers mainly because of a sharp increase in the number of early retirements and honorary retirements (about 1,000 for the last two years), which was fueled by the lowering of the retirement age. Also, compared to 5,166 in 1998, when the simulation tests were conducted, the total number of teachers is expected to plummet down to 4,100 in the year 2002. It is expected the system imbalances, caused by shortages of teachers, will persist until the year 2011, unless the current teacher supply situation is improved upon.

As shown in graph 3 of, figure 7, the reason for such imbalances in the system can be found in the fact that the number of retirees has skyrocketed. Because of the prolonged system imbalances, it is expected that the quality of elementary education will be undermined in the long run. Also, the total number of elementary schoolchildren is expected to culminate in 2003, and then start to decrease.

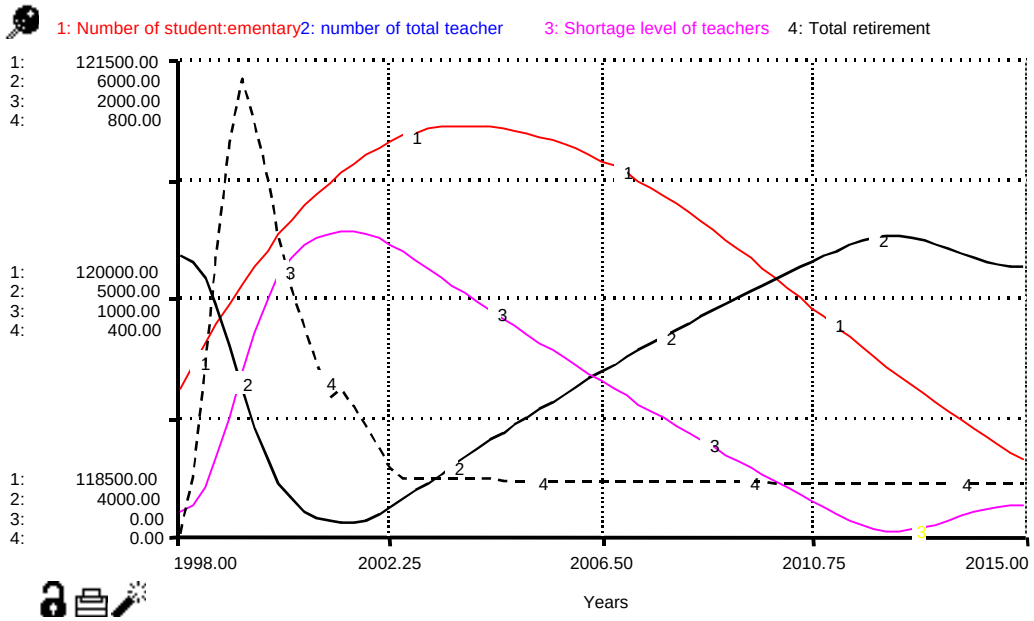

Figure 7. Result of the basic model

2. Simulation Results of the policy experimental model 1 and 2

According to the results of the simulation tests on the basic mode, the imbalance in the teacher supply and demand system in the Chung-buk province is expected to persist for the next 10 years. Policy experiment model 1 is a policy alternative designed to resolve this problem. According to the model, the shortage of teachers in the region occurred because of the relatively low number of education university graduates in the region and the low application rate of pre-teachers from other regions (as shown in <table 2> and <table 3>). The purpose of model 1 is to make predictions on the effects of the new policies, on the assumption that other problems related to the imbalances will be resolved by eliminating the imbalances. In policy experiment model 1, we increased the application rate of pre-teachers in the Chung-buk region from the current 45% to 60%, while increasing that of pre-teachers from other regions from the current 5% to 20%.

According to the simulation test results, the imbalances between teacher supply and demand will be resolved sooner under the circumstances suggested in policy experiment model 1, compared to that of the basic model. This means that the teacher shortage problem will be eliminated by the year 2004, thanks largely to newly adopted policy alternatives. In this case, the total number of teachers will reach the level of 1998, when the Ministry yet to lower the retirement age.

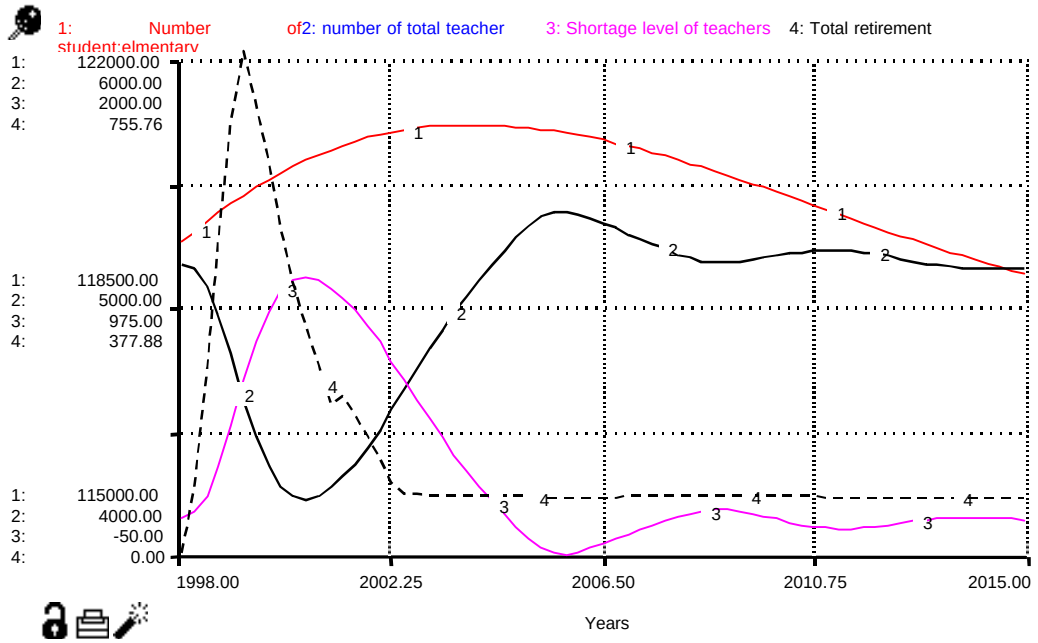

Figure 8. Result of policy experiment 1 for resolving of teacher supply-demand problem

However, it is expected that the temporarily stabilized teacher supply and demand system will be re-destabilized, due to changes in the number of newly recruited teachers (resulting from a decrease in the number of students). According to the model, however, this problem will be resolved by the year 2015. It is important to note that the success of the policy alternative depends on whether the Ministry of Education can secure a relatively high application rate of pre-teachers. In graph (3), the negative sum of the teacher shortage level represents the number of spare teachers.

In policy experiment model 2, we applied a policy alternative to the policy experiment model 1, assuming that the total number of education university entrants will be raised by 20% for the purpose of removing the shortages of teachers. The result shows that the alternative will contribute to resolving imbalances in the teacher supply and demand system (as shown in figure 9.) at an early time.

It is also predicted that if the number of education university entrants is increased, the shortages of teachers can be eliminated sooner than in the case of policy experiment model 1 and the total number of teachers will increase. Also, policy experiment model 2 suggests that if the Ministry of Education had been able to predict the shortages of teachers and increased the number of entrants in education universities across the nation before lowering the retirement age, the problems involving teacher shortages could have been avoided. Moreover, in this case, about 250 spare teachers could have been nurtured, thus enabling the Ministry to realize its policy goal of reducing the student-per-class number. It is to improve the quality of education, by hiring many new teachers instead of a senior teacher whose wage is equivalent to that of 2-3 young teachers.

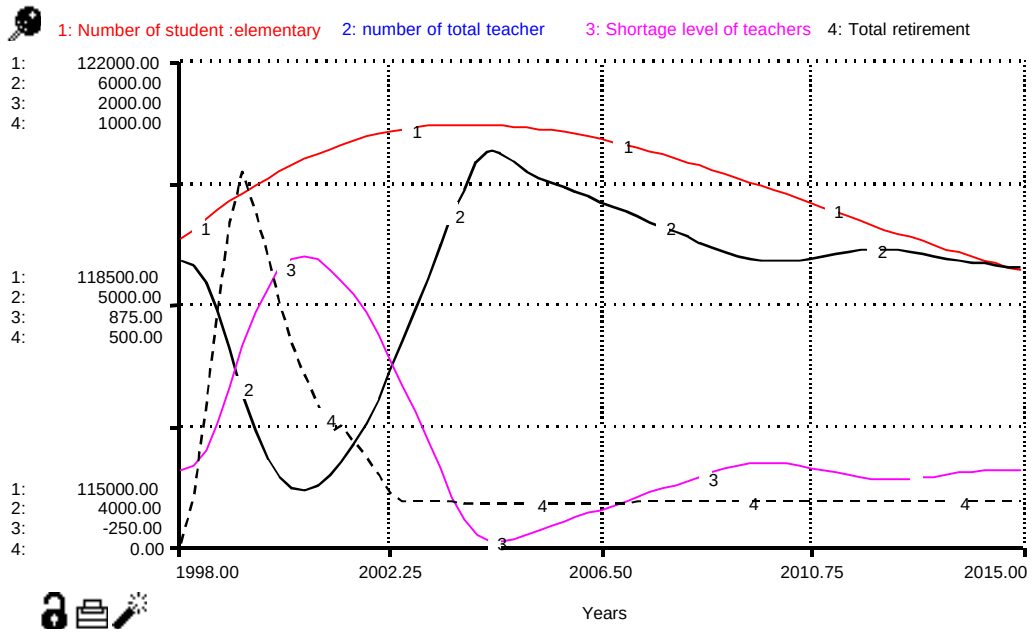

Figure 9. Result of policy experiment 2 for resolving of teacher supply-demand problem

3. Simulation Results of the Policy Experiment Model 3 and 4

In policy experiment model #3, we have experimented with the Ministry's policy goal, which is aimed at improving the quality of education by reducing the student-per-class number of elementary schools to the level of advanced nations. According to the model, reducing the number of students in a class will eventually result in an increased demand for teachers, given that Korea's elementary school education is based on class systems. Models #3 is made on the assumption that with the current teacher supply system, the current student-per-class number (which now stands at 31) will be reduced to 25, a figure close to the level of advanced nations (In the case of Britain, the figure now stands at 22). Also in model #4, we applied the policy alternatives suggested in models #1 and #2 to the circumstances in model #3, in order to find ways to resolve problems involving teacher supply.

First of all, the result of the analysis on model #3 shows that shortages of teachers (graph 3) are growing rapidly (as illustrated in figure 10.). And that even if we provide more teachers to schools (graph 2) such shortages will persist unless the current teacher supply situation is improved.

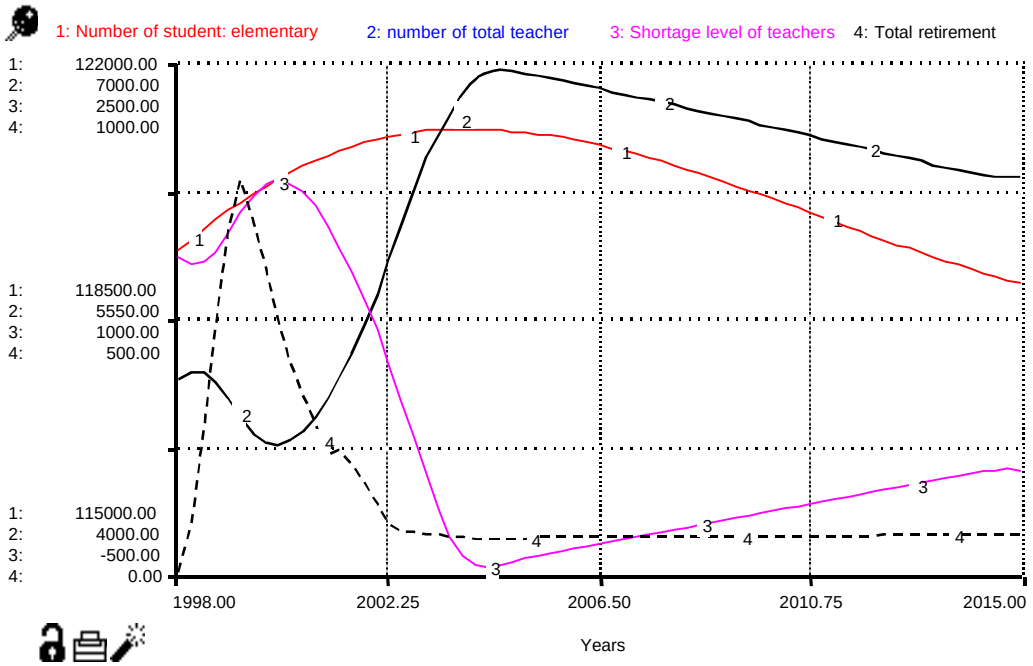

Figure 10. Result of policy experiment #3 for resolving the teacher supply and demand problem

The result shows that (as illustrated in figure 11) the shortages of teachers will be resolved no later than the year 2004, and that the number of teachers will increase from 5100 as of the year 1998 to 7000 in the year 2004. This implies that in order to reduce the student-per-class number to the level of advanced

nations, the government should have worked out measures to resolve the imbalance between teacher supply and demand, before lowering the retirement age.

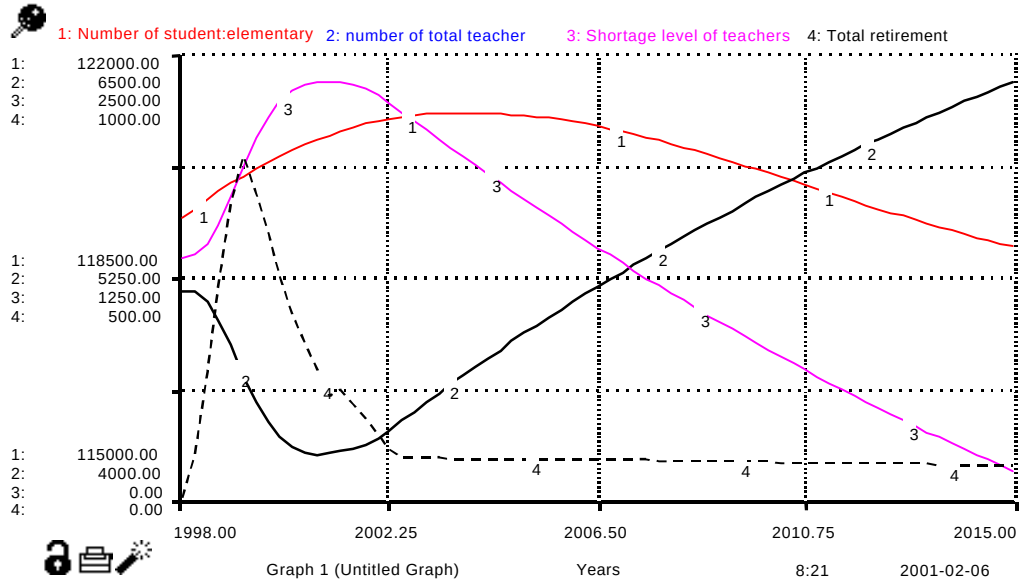

Figure 11. Result of policy experiment #4 for resolving the teacher supply and demand problem

V. Conclusion

A well-structured system has in itself the power to regain balance, but ill-structured ones, faced with serious problems, are often unable to regain balance and sometimes even collapse. As we mentioned above, the Korean Ministry of Education lowered the retirement age of teachers in the economic reform processes in order to improve the quality of education by hiring 2-3 lower wage teachers instead of a single higher wage teacher. This study is an attempt to find out the negative effects of the unexpected lowering of the retirement age and to come up with feasible solutions to those negative results.

According to our research by the system dynamics, the government's sudden move to reduce the retirement age will eventually cause a serious imbalance between supply and demand for teachers. The effects are expected to persist as long as there are no efforts to improve the current teacher supply and demand system in regions with insecure systems, most notably the Chung-buk region. The results also shows that any artificial manipulation on the system, without an in-depth analysis on the long-term system reactions, will only trigger a more serious imbalance of the system, and that the original policy goals will be remote dreams.

In addition, it is predicted that the policy alternatives, designed to resolve the supply and demand imbalance, will be effective in accelerating the problem-solving processes. The results of this experiment also imply that the problems might have not been this serious if the government had properly

implemented timely solutions. The government should have predicted a serious shortage of teachers and worked to increase the number of students at universities of education, and also tried to increase the application rate of teacher-recruitment tests in smaller regions by improving wages and working conditions.

In conclusion, we have to bear in mind that when implementing new policies in a system, it is crucial that we fully understand the structure and background of that system. We must also make sound and systemic predictions on its long-term effects, and at the same time prepare countermeasures to soften the negative effects in a timely manner.

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<Appendix: STELLA Equation (Basic Model)>

entrance:_Univ_of_Education(t) = entrance:_Univ_of_Education(t - dt) + (TO_adjustment) * dt

INIT entrance:_Univ_of_Education = 385

INFLOWS:
TO_adjustment = Shortage_level_of_teachers*0
Number_of_student:Elementary_school(t) = Number_of_student:Elementary_school(t - dt) + (enrollments - Gradutes:elementary_school) * dt

INIT Number_of_student:Elementary_school = 119409

INFLOWS:
enrollments = Number_of_student:Elementary_school*enrolment_children_rate
OUTFLOWS:
Gradutes:elementary_school = Number_of_student:Elementary_school*graduates_students_rate
number_of_total_teacher(t) = number_of_total_teacher(t - dt) + (newly_recruited_teacher - retirement - retirement_by_age_limit) * dt
INIT number_of_total_teacher = 5166

INFLOWS:
newly_recruited_teacher = DELAY(IF(Shortage_level_of_teachers>=possible_recruting_teachers) THEN possible_recruting_teachers+Shortage_level_of_teachers*apply_rate_from_other_regions ELSE Shortage_level_of_teachers, 1)
OUTFLOWS:
retirement = IF(Time>2001) Then number_of_total_teacher*retirement_rate ELSE 0
retirement_by_age_limit = effect_of_adjusted_retirement_age
pre_teachers(t) = pre_teachers(t - dt) + (Gradutes:Univ_of_Education - candidate_for_teacher) * dt
INIT pre_teachers = 0

INFLOWS:
Gradutes:Univ_of_Education = entrance:_Univ_of_Education*gradution_rate
OUTFLOWS:
candidate_for_teacher = pre_teachers*candidate_rate
apply_rate_from_other_regions = 0.045+job_satisfaction_effect
apply_rate_of_chungbuk = 0.45
+job_satisfaction_effect
candidate_rate = 1
enrolment_children_rate = 0.16*(1+children_increase_rate)
goal_of_teachers_number = number_of_teacher+(master_teacher_ratio*number_of_teacher)
graduates_students_rate = 0.16
gradution_rate = 0.99
master_teacher_ratio = 0.1
MOE_policy = 0
number_of_class = Number_of_student:Elementary_school/Standard_student_per_class
number_of_teacher = number_of_class*1.24
possible_recruting_teachers = pre_teachers*(apply_rate_of_chungbuk*rate_of_passing)
rate_of_passing = 0.99

retirement_rate = 0.016+job_satisfaction_effect
Shortage_level_of_teachers = goal_of_teachers_number-number_of_total_teacher
Standard_student_per_class = 31-MOE_policy
students_per__teacher = Number_of_student:Elementary_school/number_of_total_teacher
Total_retirement = retirement+retirement_by_age_limit
children_increase_rate = GRAPH(TIME)
(1998, 0.031), (1999, 0.0255), (2000, 0.0199), (2001, 0.0143), (2002, 0.0087), (2003, 0.003), (2004, -0.00075), (2005, -0.0039), (2006, -0.0067), (2007, -0.009), (2008, -0.011), (2009, -0.0123), (2010, -0.013), (2011, -0.013), (2012, -0.013), (2013, -0.012), (2014, -0.011), (2015, -0.00915)
effect_of_adjusted_retirement_age = GRAPH(TIME)
(1998, 0.00), (1999, 803), (2000, 410), (2001, 150), (2002, 0.00), (2003, 0.00), (2004, 0.00), (2005, 0.00), (2007, 0.00), (2008, 0.00), (2009, 0.00), (2010, 0.00), (2011, 0.00), (2012, 0.00), (2013, 0.00), (2014, 0.00), (2015, 0.00)
job_satisfaction_effect = GRAPH(students_per__teacher)
(15.0, -0.0099), (17.0, -0.0071), (19.0, -0.0044), (21.0, -0.0023), (23.0, 0.0001), (25.0, 0.0019), (27.0, 0.0037), (29.0, 0.0054), (31.0, 0.0071), (33.0, 0.0085), (35.0, 0.0098)