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A Comparative Study on Science Teacher Education System

Sungmin Im*, Junehee Yoo & Sung-Jae Pak*

(Seoul National University* · Korea Institute of Curriculum & Evaluation)

ABSTRACT

An important issue for qualified science teacher education should be a proper system of pre-service education for the science teacher. There are various types of science teacher education systems in accordance with their socio-cultural backgrounds. In this paper, science teacher education systems were analysed into 3 different types: Focusing Undergraduate Certification of Education (FUCE), Open Undergraduate Certification of Education (OUCE), and Post Graduate Certification of Education (PGCE). Science teacher education systems and their outcomes, such as the quality of the science teacher, were discussed with their socio-cultural backgrounds, compared by the 3 types of science teacher education systems. For this the results of meta-analysis from TIMSS-R and OECD data sets were used. Special interests focused on countries; Japan, Korea, the United Kingdom and the United States, which would represent stereotypes of science teacher education systems and different backgrounds of oriental and western culture.

Key words: science teacher education system, Focusing Undergraduate Certification, of Education (FUCE), Open Undergraduate Certification of Education (OUCE), Post Graduate Certification of Education (PGCE), cultural index

I . Introduction

It is said that the quality of education depends largely on the quality of teacher, and science education would not be an exception. The quality of science teacher is strongly related to the system of science teacher education (Kim *et al.*, 1990). And the quality of science teacher can be a cause for the differences of students achievements in international comparative studies like TIMSS (Martin *et al.*, 2000).

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But the education system, including science teacher education, is so deeply related to socio-cultural backgrounds that it cannot be analysed without considering them, for example, the environment for teaching science, social value, attitude towards the science teacher, merits of science teacher as a job, economic backgrounds, etc. Also, cultural differences can be used as an argument against simplistic interpretation of the differences in science teacher education systems as well as students achievements (National Research Council, 1999).

Qualified science teacher education could be satisfied by the relevant science teacher education system. Therefore, to analyse the science teacher education system with the consideration of its socio-cultural backgrounds can offer insight for favourable science teacher education (Pak *et al.*, 1987; Pak *et al.*, 1993).

The purpose of this study is to compare the various science teacher education systems for a pursuit of the relevant science teacher education system in consideration of its socio-cultural background. For this, we analysed the science teacher education systems of 4 different countries, and compared the various science teacher education systems and outcomes with their socio-cultural backgrounds.

Ⅱ. Research method and contents

In this paper, science teacher education systems were analysed into 3 different types such as Focusing Undergraduate Certification of Education (FUCE), Open Undergraduate Certification of Education (OUCE), and Post Graduate Certification of Education (PGCE). The science teacher education systems and their outcomes, such as the quality of science teachers, were discussed with their socio-cultural backgrounds by being compared to the 3 types of science teacher education systems.

For this the results of meta-analysis from TIMSS-R and OECD data sets were used (Martin *et al.*, 2000; OECD, 2001). Special interests were focused on the four countries, Japan, Korea, the United Kingdom, and the United States, which would represent stereotypes of science teacher education systems and different cultural backgrounds. In addition, our study is confined to primary and secondary school science teacher education.

There were preliminary presentations and panel discussions for this comparative study with resource people from each country at the International Conference on Physics Education in Cultural context (ICPEC) on August 2001. After these presentations and panel discussions, some corrections and comments were considered in this paper.

Ⅲ. Analysis of science teacher education systems

1. The types of science teacher education systems

The first type, Focusing Undergraduate Certification of Education (FUCE), refers to the system that exists within the colleges of education at the undergraduate level, which take exclusive responsibility for teacher education. The colleges of education, in the case of the FUCE type have various departments as well as various subject matters. For example, there are the departments of science education or the departments of physics education in universities. An individual who wants to be a science teacher should graduate with a science education major in the college of education, and he or she earns to get the certification of science teacher. So the deciding time to be a teacher is at the entrance of university. It is similar to the college of medicine that takes exclusive responsibility for the education and training of medical doctors. The College of Education in Korea, the Teachers College in Japan and the Ecoles Normale in France are examples of this type.

The second type, Open Undergraduate Certification of Education (OUCE), refers to the system in which the undergraduate courses are open, and one can be a teacher if he or she takes the required teaching professional courses for the certification of education at the undergraduate or graduate level. Some teachers in Korea and Japan come to be teachers through this type of system nowadays, and many aspects of teacher education systems in the USA belong to this type. In OUCE, one can decide to be a teacher during undergraduate study.

Table 1. Some features by the type of science teacher education system

Type	FUCE	OUCE	PGCE
Meaning	Focusing undergraduate certification of education	Open undergraduate certification of education	Post graduate certification of education
Teacher Education Program	Science education major in UG	Science major in UG. + requirement of certain subjects for certification in UG	Science major in UG. + special teacher training course in graduate level.
Educational term	Completion of UG course (2~4 years)	Completion of UG course (2~4 years)	Completion of graduate course (4~6 years)
Necessary condition for certification	Graduation of UG	Graduation of UG with required subjects	Graduation of PGCE course
Deciding time to be a teacher	At entrance of university	During undergraduate	After graduation
Examples	College of education (Korea)	Teaching profession course in university (USA)	Initial teacher training course in graduate level (UK)

The third type, Post Graduate Certification of Education (PGCE), refers to the system in which those who finish undergraduate courses and then take intensive educational courses in graduate school can receive the certification to be a science teacher. It is similar to OUCE in the respect that the undergraduate courses are open, but is different in that the PGCE type has a separate institute for being a teacher at the graduate level.

In OUCE, one can decide to be a teacher after graduation from the university, which is not so dependent on ones major as an undergraduate. The PGCE courses in the UK and the IUFM courses in France are examples of this type.

2 Comparison of science teacher education systems by countries

There can be a typical type of science teacher education system but it is hard to say that there is just one type of teacher education system in a country. In most countries, various types of teacher education systems are mixed in practice. In this section we analysed various types of science teacher education systems in respect to the above 3 typical types, and compared the features of science teacher education systems from the four sample countries; Japan, Korea, the UK and the USA.

(1) Japan

There are Colleges of Education, Teachers Colleges and teacher training institutes as a part of the university that take exclusive responsibilities for teacher education. It can be a FUCE type and traditionally this was the typical type for being a science teacher in Japan. But there exists teaching profession courses in a university regardless of a College of Education as an OUCE type, so that one who completes this course comes to get the qualification to be a teacher. In general, Teachers Colleges and Colleges of Education take care of the education for primary and junior high school teachers, and teaching profession courses of the university take care of education for high school teachers. The FUCE type and the OUCE type are mixed in Japan. The FUCE type was the traditional and typical type but recently the OUCE type has come to be dominant. There also exists the PGCE type for professional certification, but it is not so general. However, one should pass the examination regardless of the types due to the hot competition that exists to be employed as a teacher.

(2) Korea

Science teacher education in Korea was focused on undergraduate education in the Colleges of Education, which take exclusive responsibilities in teacher education. For example, one who wants to be a physics teacher should graduate from the department of physics education in the College of Education. However, taking a teaching profession course

in the College of Natural science can be another way to be a science teacher (Korean Society of Subject-Matter Education, 2001). Traditionally, the FUCE type is the typical way to be a science teacher in Korea, but nowadays many more people get the certification of science teachers via the OUCE type. In a few cases some come to be science teachers by the PGCE type, but the main purpose of the PGCE type is concentrated on educational research. Everyone who graduates from the College of Education or completes the teaching profession course comes to get the teacher certification. To be employed, one should pass the examination because the competition is extreme. Recently, the unemployment of those who have a teachers certification has become a social problem, and it is similar to the case of Japan.

(3) UK

In the UK, there exists the Teacher Training Agency (TTA), a separate organization which takes exclusive responsibility in teacher education. Those who complete the Initial Teacher Training (ITT) course arranged by TTA can be teachers. ITT courses can be divided into two types. The first one is an undergraduate ITT course, which can be divided again into a full-time ITT program and a shortened-time ITT program. In the full-time ITT program, one can take an educational program during the full-time undergraduate coursework (3 years) or extended educational coursework (3+2 years). It is similar to the FUCE type. In the shortened time ITT program, one can take a two-year educational program as an undergraduate, which is relatively independent of ones major upon entrance to the university. This can be a kind of OUCE type. In general, the shortened-time ITT program takes care of pre-service teachers for primary school. Those who graduate from the undergraduate ITT course get B. Ed. degrees or B. Sc degrees and get the teacher certification called Qualified Teacher Status (QTS).

The second type is a graduate ITT course in the post-graduate certificate education (PGCE) system. Those who graduated from the university and have B. Sc. degree can take the graduate ITT course at the university for an additional 3 semesters to be science teachers, and get the qualification for QTS. The intensive educational courses and practical teaching experiments are emphasized in the graduate ITT program. In the UK, the PGCE type is a more popular way to be a science teacher.

(4) USA

There are so many various science teacher education systems in the USA that it is hard to discuss the typical teacher education system as a whole. However, in general the science teacher education system of the USA is said to be an OUCE type. Although there exist Teachers Colleges and Colleges of Education as institutes for teacher education, those are not general cases for teacher education. Instead, the teaching profession courses in the

universities take many more responsibilities for teacher education. In this type of teacher education system, one who wants to be a science teacher should take the required course for the teachers certification. In many cases, the department of education takes part in teaching educational theory and the departments in the College of Natural science or Engineering take part in teaching the content knowledge of science.

Table 2. Comparison of science teacher education systems by sample countries

	Japan	Korea	UK	USA
Necessary condition for certification	Completion of teacher education course in various level	Completion of teacher education course in UG level	Complete of ITT program	Completion of teaching professional course and examination
Certification	Profession/ 1st class/ 2nd class	2nd class teacher certification	Qualified Teacher Status	
Employment	Examination	Examination	Call	Call
Recruitment	Oversupply	Oversupply	Deficiency	Deficiency
Features of FUCE type	Science education major in college of education (For primary and junior high)	Science education major in college of education (Typical)	FulltimeITT (3~5 yrs) programs (For primary)	School of education
Features of OUCE type	Teaching professional course in college (For high school)	Teaching professional course in college	Shortened time (2 yrs) ITT program	4-yrs program in UG as professional career education (Typical)
Features of PGCE type	Graduate school or graduate school of education (For professional certification)	Graduate school or graduate school of education (For educational research)	Graduate-ITT programs (More popular to be a teacher)	Graduate school for educational research (For educational research)
Comments	FUCE (traditional) OUCE (recent)	FUCE (traditional) OUCE (recent)	PGCE is more ample than FUCE	In most case OUCE

Ⅳ. Socio-cultural background of science teacher education

1. Educational environment

The general educational environment (the investment to education in general and teachers salaries), the environment for science education (science class size) and Availability of Science Resources in Science Instruction by the TIMSS-R report are compared as a social background of science teacher education (Table 3).

Japan, the UK, and the USA have a better educational environment than Korea in the investment to education, science class size, and instructional resources. On the other hand, science teachers salaries in Korea are relatively higher than those of the other countries.

Table 3. Comparison of educational environment

Content	Japan	Korea	UK	USA
Investment to education (%/GDP)	42.7	24.7	39.7	-
Science class size (persons/class)	36	43	-	26
Availability of science resources in science instruction	30/100	7/100	27/100	34/100
Teachers salaries ratio to GDP per capita (starting)	-	1.50	0.89	0.74
Teachers salaries ratio to GDP per capita (after 15yrs)	-	2.50	1.50	0.99

(source: OECD report, 2001, and TIMSS-R report, 2000)

2. Science teachers

Some points about science teachers, such as the traditional image of teaching as a job, recruitment, gender ratio for science teachers, and qualifications of a science teacher are compared as a social background of science teacher education (Table 4).

In oriental cultures like Japan and Korea, the images for teachers are respected, while in the western cultures of the UK and USA teaching is viewed as professional. For the recruitment of teachers in Japan and Korea, those who want to be teachers are greater than the demands, which became a social problem. It is greatly contrasted to the cases of the UK and USA, in which the deficiency of teachers related to the demand is a social problem. Japan and Korea have similar situations for science education in general but in terms of gender ratio of science teachers there is a distinct difference; that is, in Japan a greater percentage of science teachers are male. The qualifications of science teachers

having both a science major and certification are much better in the cases of Korea and the UK than the cases in Japan and the USA.

Table 4. Comparison of science teachers background

Contents	Japan	Korea	UK	USA
Teachers status	Respected	Respected	Profession	Profession
Recruitment	Oversupplied	Oversupplied	Deficient	Deficient
Gender ratio (M:F)	79 : 21	41 : 59	57 : 43	52 : 48
Science major in college	86/100	93/100	95/100	71/100
Certification	100/100	98/100	95/100	-
Science major & certification	86/100	91/100	90/100	-

(source: TIMSS-R report, 2000)

3. Students

Student variables, such as achievement in science and learning attitudes indicated in the TIMSS-R report Students Interruption in Science Instruction, Positive Attitude Towards Science are compared as a social background of science teacher education (Table 5).

Japan and Korea have similar situations regarding students in a science class. Interruptions in science class are rarer than those of other countries. There seems to be teacher-centered science instruction in Japan and Korea. The achievements in science are highly ranking in Japan and Korea but their attitudes towards science are lower. The UK and USA also have similar situation about science education in many aspects except for students achievements in science.

Table 5. Comparison of students in science class

Contents	Japan	Korea	UK	USA
Interruption in instruction (Never interrupted)	64/100	61/100	14/100	13/100
Positive attitude towards science (high 10%)	10/100	10/100	39/100	32/100
Achievement in science	4^{th}	5^{th}	9^{th}	18^{th}

(source: TIMSS-R report, 2000)

4. Cultural indices

The economist and psychologist, Greet Hofstede introduced several cultural indices to describe various cultural aspects of different countries in the world (Hofstede, 1991). Here we compared some cultural indices of exemplary countries, and explored the relevance of proper science teacher education systems and their cultural backgrounds.

1) Power distance index (PDI)

PDI reveals inequality in society. In a country revealing high PDI, the authority by ones position is important in an institute or an organization, including school. In such a country, students are more dependent on teachers and respect teachers. So the quality of education is much more dependent on the excellence of the teacher in such a country. However, in a country that revealed a low PDI, the communication between teachers and students is more important. Korea revealed a relatively higher PDI than the USA and UK, and this corresponds to the fact that more Korean students respect their teacher and the teacher has more authority in Korea.

2) Individualism index (IDV)

IDV reveals the individualism in a society contrasting collectivism. In a society with high IDV, the individual benefit is more important. In a school of such a country, mutual communication is an important factor of teaching and learning. On the other hand, a country with low IDV is likely to demonstrate a more teacher-centred instruction. In a society that stresses individualism, knowing how to learn is more important, while in a society that focuses on collectivism, more importance is placed on knowing how to work. Korea revealed the lowest IDV among example countries, therefore education depends much more on the teacher than that of other countries. Therefore to ensure and train the qualified science teacher is the most important task for the excellence of science education.

3) Masculinity index (MAS)

MAS reveals the tendency of masculinity in a society. In a society of masculinity, the roles of male and female can be clearly distinguished. According to Hofstede, the author who introduced these cultural indices, masculinity means the tendency of self-assertion, toughness, the pursuit of physical success while femininity means the tendency of modesty, gentleness, and the pursuit of a quality life. In a school with a masculine society, achievement in school is very important and students tend to reveal their excellence while in a feminine society, modesty for their ability is regarded as a virtue. Also, in a masculine society, female teachers tend to teach younger children and male teachers generally teach older students. Japan revealed the highest MAS, and this can explain why the gender

distribution of science teachers leaned more toward men.

4) Uncertainty avoidance index (UAI)

UAI reveals the perceived uneasiness of individuals against an uncertain context or strange environment. In a society of high UAI, students pursue the right answer and expect teachers to be experts who know everything while in a society of low UAI, students enjoy an open learning context and like teachers who use plain words. In the UK, which reported the lowest UAI, students get used to and enjoy the open investigation or practical work in science education. While in Japan and Korea, countries with high UAI, students show a strong tendency to focus on right answers.

5) Long-term orientation index (LTO)

LTO reveals the Confucian value in a society. For example, patience, order by position, husbandry, sense of honour, pursuit of virtue, and synthetic thinking belong to long-term orientation. Many countries of East Asia including Japan and Korea revealed high LTO, and such countries showed rapid and expansive economic growth in the late 20^{th} century. It would be not so easy for students in Korea and Japan to learn the western ideals of modern science as those countries revealed much higher LTO than others.

Table 6. Some cultural indices as a background of science teacher education (full mark=100)

Cultural indices	Japan	Korea	UK	USA
Power distance indices (PDI)	54	60	35	40
Individualism indices (IDV)	46	18	89	91
Masculinity indices (MAS)	95	39	66	62
Uncertainty avoidance indices (UAI)	92	85	35	46
Long-term orientation indices (LTO)	80	75	25	29

(source: G. Hofstede, 1991)

V. Summary and conclusion

For qualified science teacher education, an analysis of various science teacher education systems is pursued with their socio-cultural backgrounds. In this study we confined science teacher education systems into 3 different types: Focusing Undergraduate Certification of Education (FUCE), Open Undergraduate Certification of Education (OUCE), Post Graduate Certification of Education (PGCE), and focused upon Japan, Korea, the UK, and the USA.

In Japan, the FUCE type was traditional but recently the OUCE type has come to be

dominant. In most cases primary and junior high school teachers come from the FUCE type, and high school teachers come from the OUCE type. In Korea, science teacher education was focused on undergraduate education in Colleges of Education, which takes exclusive responsibility in the education of teachers. Japan and Korea show similar social backgrounds, except for a few aspects, and share similar cultural background such as strong collectivism and long-term orientation originated in Confucianism.

There are some similarities in science teacher education for Japan and Korea. First, the FUCE type is the traditional teacher education type and the traditional emphasis has been put on teachers in both countries. Second, the two countries showed strong collectivism and long-term orientation originated in Confucianism. Third, the role of the teacher is more important in science education than in other countries, and traditionally people tend to respect the teacher. Also, students achievements in science are highly ranked in both countries.

In the UK, the PGCE course at the graduate level is more typical type although there exists undergraduate teacher training courses such as the FUCE type and OUCE. In the USA, although there are various science teacher education systems, the OUCE type is most typical as a science teacher education system

The UK and USA share very similar socio-cultural backgrounds, that is, a Western culture background which differs completely from that of Korea and Japan. In spite of the similar socio-cultural backgrounds of the USA and UK, there is somewhat of a difference in students achievements between the two countries. This leads us to reflect upon what a more relevant science teacher education system is.

For the pursuit of qualified science teachers, a relevant science teacher education system should be discussed and this can be possible with the consideration of the socio-cultural background of a country.

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