

## A Study on Science Education Courses for Secondary School Science Teachers Preparation

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### I. INTRODUCTION

In addition to the courses related to liberal arts, science, and general education, the science education courses must be unique and nuclear ones for science education majors. Nevertheless, the importance of science education courses have not been recognized, and usually one course has been required to the physics, chemistry, biology and earth science education majors in Korea.

This study was started to pursue a status survey of the courses at the colleges of education by questionnaires at first and interviews for cross-checking, and to develop models of the science education courses.

Production of instructional materials and practical teaching for the feedback process will be followed.

### II. A STATUS SURVEY OF SCIENCE EDUCATION COURSES

Table 1. Number of science education department and responses

Department or major	Total No.	Responded chairperson	Responses by instructors
Physics education	16	11	20
Chemistry education	16	7	12
Biology education	18	7	16
Earth science education	9	5	10
<b>Total</b>	<b>59</b>	<b>30</b>	<b>58</b>

There are 59 science education departments or majors as table 1 at nine national and ten private colleges or universities in Korea. (cf. Appendix 1)<sup>(3)</sup>

Among them, 30 department or major chairpersons responded to the questionnaire which were distributed to them, asking about the curriculum and especially on science education courses. Four chairpersons from each area of physics, chemistry, biology or earth science were interviewed by this researcher for cross-checking of the questionnaire.

The instructors who have had an experience to teach science education courses responded another questionnaire for specific aspects of science education courses. Sometimes more than one instructor from a department and some case more than one course from an instructor responded the questionnaire so that the total number of the response was 58 as shown in table 1.

#### 1. Required Credits

The average number of compulsory required credits for B.S. degree and science teaching certificate of secondary school was 141 as shown in table 2.

Table 2. Required credits for B.S. degree and teaching certificate.

Course category	Average	Minimum	Maximum
Liberal arts	46.1 (32.6%)	30	69
Education	18.0 (12.7%)	14	22
Major	59.9 (42.4%)	45	84
Others	17.3 (12.3%)	2	41
<b>Total required</b>	<b>141.3 (100.0%)</b>	<b>140</b>	<b>148</b>

Science education courses are belong to the category of either general education or major, or sometimes in both categories. It was found that the average percentage of compulsory courses for science education was 3.2% and optional ones 0.9% of the total required credits as shown in table 3.

Table 3. Required credits of the courses related to education.

Courses	Average	Minimum	Maximum
General education theory	13.9 (9.9%)	12	16
Practical teaching	2.1 (1.5%)	2	3
Science education * (compulsory)	4.5 (3.2%)	2	8
Science education* (optional)	1.2 (0.9%)	0	6
<b>Total</b>	<b>21.7(15.5%)</b>	<b>16</b>	<b>33</b>

\*Sometimes these courses are belong to the category of major courses.

## 2. Science Education Courses

There were 6 departments which offered only one science education course, 20 departments two courses and 4 departments three courses. The distribution of the department number according to the total credits of the offered science education courses was as shown in the following table 4.

Table 4. Distribution of department number according to the offered credits of science education courses.

Offered credits	2	3	4	5	6	7	8	9	10
No. of dept.	2	4	5	3	12	0	0	4	0

Even though the offered courses related to science education by each department was so small (1-3 courses), the title of the courses were so various as about 15 different by each major. Nevertheless the content of the most popular courses could be converged into physics, chemistry, biology or earth science "teaching method" and "teaching materials", even though the terminologies of the course title were not exactly the same in Korean. (cf. Appendix 2)

## 3. Students and Instructors of Science Education Courses

The students of science education courses were mainly upper grade ones as shown in table 5.

Table 5. Students of science education courses

Grade	Freshmen	Sophomore	Junior	Senior
Rel. Freq. (%)	0	3.0	51.5	45.5

The instructors of the science education courses were more senior faculty members as shown in table 6.

Table 6. Instructors of science education courses.

Position	Professor	Asso. Prof.	Assi. Prof.	Part time Instructor
Rel. Freq. (%)	47.8	26.1	17.4	8.7

## 4. Description of Science Education Courses

The responses of 58 courses related to science education were analyzed according to the course objectives, contents, instructional materials and methods of assessment.

### (a) Objectives of the Courses

The variously mentioned course objectives were analyzed as following table 7.

Table 7. Objectives description

Classification	Frequency
Knowledge, understanding	24
Application	12
Practical skills, techniques	12
No response	30

More than one third of the response did not describe at all about course objectives and no single items on affective domain objectives.

### (b) Contents of Science "Teaching Method" Course

For the general picture of the most popular course, "teaching method" course contents were analyzed to check item frequency as in the following table 8.

Table 8. Contents frequency of science "Teaching Method" courses

Content Items	Relat. Freq. Percent(%)
Nature & History of Science*	5.3
History & current issues in science education	7.4
National curriculum of secondary schools	9.6
Objectives of science education	12.8
Concept contents of science teaching	8.5
Learning psychology of science	6.4
Teaching models & techniques of science teaching	20.2
Lesson plan	9.6
Facilities, equipment, printed & A.V. materials	4.3
Measurement & evaluation in science teaching	11.7
Observation of class teaching practice	3.2
Research of science teaching	1.1

\*Many cases are mentioned as physics, chemistry, biology or earth science instead of science.

(c) Contents of Science "Teaching Materials" Courses

The content items frequency of the science "teaching materials" courses were also analyzed as following table 9.

Table 9. Contents frequency of science "Teaching Materials" courses.

Content items	Relat. Freq. Percent (%)
Korean textbooks of secondary schools	50.0
Foreign textbooks of secondary schools	20.8
Design, practice & analysis of experiment	20.8
Design & production of simple equipments	4.2
A.V. materials use and development	4.2

(d) Instructional Materials

There were items in the questionnaire asking to write the printed materials, A.V. aids, and lab equipment, but only small number of title of printed materials was described as table 10.

(e) Methods of Assessment

Various methods of assessment of the responded courses

were analyzed by checking the relative frequency and described in percentage as table 11. Most of the instructors used two or three methods to decide final marks.

Table 10. Printed materials used for science education course

Items	No. of responses
a. National Textbook	21
b. Foreign Textbooks	18
c. Science education by Chung Y.T. etc.	10
d. New Science Education by Choi J.N. etc.	1
e. Inquiry Technique in Science Teaching by Romey	1
f. The Process of Education by J. Bruner	1
g. New Trends in Chemistry Teaching by UNESCO	1

Table 11. Methods of Assessment for Science Education courses

Method	Relat. Freq. Percent (%)
Pencil and paper test	35.4
Report	27.4
Presentation, discussion	16.1
Production of teaching materials	11.3
Teaching exercise	6.5
Participation in the class	3.2

### III. INSTRUCTORS' OPINIONS ON SCIENCE EDUCATION COURSES

In addition to the status informations, the instructors' opinions on science education courses were also collected and analyzed.

1. Percentage of Science Education Courses

The opinion of the instructors about how many per-

Table 12. Opinion on the percentage of required credit of science education courses

Percent of Sci. Edu. Courses (%)	3	5	7	10	12+
Rel. Freq. Percent of Instr. (%)	0	20.8	33.3	37.5	8.3

centage for science education courses would be proper among the assumed 140 credits for bachelor degree and certificate of teacher is mentioned in the table 12. They proposed much higher percentage of science education courses, comparing To the present situation of 3%.

## 2. Preferred Courses

The instructors were asked to check any of the titled courses in table 13, whether they think it should be compulsory or optional. The numbers in the table 13 are absolute frequency that the instructors checked.

Table 13. Instructors' response to science education related courses

Course	Com- pulsory	Option- al	No need	Neu- tral
Secondary Science Education	32	2	2	
Junior High Science Teaching	4	8	2	6
Senior High Science Teaching	2	8	6	2
Physics/Chemistry/Biology/ Earth Science Teaching	22	12	2	
Physics/Chemistry/Biology/ Earth Science Materials	28	12	2	
Design & Workshop of Science Equipment	8	20		
Seminar of Science Education	4	18		4
Research in Science Education	4	10		6
Philosophy and History of Science	6	22		

The comprehensive introductory course titled "Secondary Science Education" was the most frequently checked one as a compulsory course, and the "teaching method" and "teaching materials" courses were the next recommended ones.

## 3. Science Education Courses for Lower Grade Students

For the question whether science education courses should be required to the freshmen and/or sophomore students of science education major, 68% of the responded instructors agreed, especially recommending the philosophy and/or history of science course. Some of them insisted early

orientation of science education would give better pre-service education of science teachers. The other 32% of the instructors disagreed the early teaching because they think first of all curriculum revision would be very difficult and the young students need more study of science at the lower grades.

## 4. Issues and Problems in Teaching Science Education Courses

One item of the questionnaire was to ask writing the issues and problems in teaching science education courses. According to the order of more frequently mentioned item, the issues can be summarized as the following table 14.

Table 14. Issues in teaching science education courses

Issues and/or Problems	Mentioned Frequency
Short of teaching materials for science education course	28
Lack of other related people's understanding	22
Need of more compulsory courses	18
Qualification of the instructors	14
Poor facilities & financial support for research	8

## IV. DEVELOPMENT OF SCIENCE EDUCATION COURSES

A procedural model of the course development has been proposed by this researcher and discussed at the workshop of instructors, which was held in Seoul.

The proposed basic guides and conditions of science education courses development were as following.

### 1. Both Deductive and Inductive Approach

Deductive approach connotes the discussion of science education from the background or the view points of the nature of science, general theories of educational psychology, and various demands of social change in broad sense.

Inductive approach means the study of the detailed practical teaching of the basic concepts of science and scientific process skills, such as mass, Newton's laws, observation, inferring etc.

Such approaches should not be isolated from each other, but supplemented or interconnected meaningfully by continuing study.

## 2. Coordination of Theories and Practices

It will be a quite difficult task for instructing staff members to offer the science education courses in harmony of the various theoretical aspects and the present situation of the schools, which require professional research on science education and school teaching experience of science. Nevertheless, such efforts are badly required for the meaningful and successful education of science teachers.<sup>(1)(2)</sup>

## 3. Portion of Science Education Courses

It is this researcher's proposal that about 10% of total required credits, which corresponds 14 hour-credits assuing 140 for the degree and certificate, should be for science education courses in addition to the practical teaching at laboratory schools by decreasing other courses such as general education theory, or by increasing the total required credits for the degree and certification. Among them, it might be 8% for compulsory and 2% optional courses.

Table 15. The Proposed Courses of Science Education

Title of the	Some Characteristics	Grade-Sem.
<b>Compulsary</b>		
(a) Secondary School Science Education	Introductory, deductive, Junior h.s. emphasis	Junior-I
(b) Physics/ Chemistry Biology/Earth Science Teaching	Inquiry, inductive, discipline emphasis	Junior-II
(c) Workshop of Science Teaching Materials	Design, production, repairing, management	Senior-I
(d) Practical Teaching	Laboratory school, at least 5 weeks	Senior-I
<b>Optional</b>		
(a) Philosophy or History of Science		Sophomore-I
(b) Special Topics in Science Education		Sophomore-II
(c) Individual Study of Science Education		Senior-II
(d) Graduate Courses at Lower Levels		Senior-II

However, the skeleton of the most popular course recommended in the questionnaire are as follows:<sup>(2)(4)</sup>

## 4. Proposing Science Education Courses

The proposed science education courses are outlined in the table 15. The detail will be described in the expected continuing study and printed materials.

### a. Outline of "Secondary School Science Education" Course

1. Science, Technology and Secondary School Science
2. Student, School and Teaching Science
3. History and Issues of School Science Education
4. Goals and Objectives of Junior and Senior High School Science Teaching
5. Selection and Organization of Contents for Science Teaching
6. Learning Psychology and Instructional Method of Teaching Science
7. Evaluation of School Science Education
8. Science Lab, Facilities, Equipments, Printed and A.V. Materials
9. Policy, Administration, Finance, Supervision, and other Supporting Activities for School Science Teaching
10. Research Work and Professional Activities of Secondary School Science Teachers.

### b. Outline of "Physics Teaching" Course

#### Part I

1. Teaching measurement and units in physics
2. Teaching classical mechanics
3. Teaching heat, thermodynamics and statistical mechanics
4. Teaching waves, optics and acoustics
5. Teaching electricity, magnetism and electronics
6. Teaching atomic and molecular physics
7. Teaching relativity and cosmology

#### Part II

8. Historical survey of physics education
9. Physics education in foreign countries
10. Physics education in Korea
11. Physics education in the Future

Part III

12. Nature and social relation of physics and physics education
13. Relation of teaching physics, math and technology
14. Characteristic features of teaching physics of J.H.
15. Characteristic features of teaching physics of S.H.
16. Research and development of physics teaching

V. CONCLUSION

It is an ironical situation that science education courses are not so well recognized as a core part of science teachers education.

With the strong background of science and general education study, science education courses must be developed and taught meaningfully to science education majors.

This study which was intending to pursue a series of development activities for science education courses, just started and did a status survey to initiate formation of developmental model, which proposed at least 10% of science education courses among the total required credits for B.S. degree and science teacher certificate, and took a strategy of a deductive and inductive approach in the harmony of theories and actual situation.

Production of teaching materials, pilot teaching and feedback process through evaluation will be followed.

REFERENCES

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- (3) Ministry of Education, Statistical Yearbook of Education, Republic of Korea, 1982.
- (4) Trowbridge, L.W., Bybee, R.W. & Sund, R.B., Becoming a Secondary School Science Teacher, Charles E. Merrill Pub. Co., 1981.

Appendix 1. Colleges and Universities with Science Education Department or Major

Nat'l Priv.	Name	Physics	Chemistry	Biology	Earth	Remark
		Ed.D/M	Ed.DM/	Ed.D/M	Ed.D/M	
Nat'l	Cheju	O	X	O	X	
	Choongbuk	O	O	O	O	
	Junbuk	O	O	O	O	
	Junnam	O	O	O	O	
	Kongju	O	O	O	O	
	Kyongbuk	O	O	O	O	
	Kyongsang	O	O	O	X	Sci Edu Dept
	Pusan	O	O	O	O	
	Priv.	Chosun	O	O	O	O
Ewha W.		O	O	O	O	
Hyosong W.		X	O	O	X	
Chungju W.		X	X	O	X	
Kugmin		O	O	X	X	Sci Edu Dept
Taegoo		O	O	O	X	
Tongkuk		O	O	O	X	
Sangji		O	O	O	X	Sci Edu Dept
Sangmeung		X	O	O	X	
Wongkang		O	X	O	X	
<b>Total</b>	<b>19</b>	<b>16</b>	<b>16</b>	<b>18</b>	<b>9</b>	

Appendix 2. The Korean Title of the Courses Offered for physics Education Majors.

물리 교육과 학생을 위해 개설하는 물리 교육 과목

교 과 목	학점	시 간	필/선	학년	학기	담 당
물리 교수법	3	3	필	4	I	교 수
물리 지도법	2	2	필	3	II	전임강사
물리과 지도법	2	2	필	3	I	조 교 수
물리학습지도법	2	2	필	3	I	교 수
물리과 지도법 및 특별 활동	2	3	필	4	I	교 수
교재 연구	3	3	필	4	II	교 수
물리교재연구	3	3	필	3	II	부 교 수
물리교재분석	2	2	선	4	I	교 수
물리학 교재론	2	2	선택필	4(3)	I(II)	조 교 수
물리시설교재연구	3	3	선	3	II	조 교 수
물리 교육	3	3	필	3	II	부 교 수
물리교육이론및실습	3	4	필	3	II	교 수
물리교육연구	2	2	선	4	II	교 수
물리 학 사	3	3	선	3	I	교 수
	2(7)	2(6)	필 (8)	3(8)	I(7)	교 수(8)
	3(7)	3(7)	선 (6)	4(6)	II(7)	부 교 수(2)
		4(1)				조 교 수(3)
						전임강사(1)

## 초 록

# 중등 과학교사 양성을 위한 과학교육과목의 실태 분석과 시험적 모형 연구

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(1984년 12월 1일 받음)

중등 과학교사 양성에 있어서 기초 교양 과목과 교육 일반론 및 과학 과목은 중요한 부분이지만 가장 핵심적이고 특유해야할 과목은 과학교육 관계 과목이다. 많은 경우 2~3학점의 한 과목을 필수로 제시되는 “물리교육”, “화학교재”, “생물교수법” 등의 분야별 과목이 안이하고 무의미하게 제시되는 것이 아닌가 하는 직관적 판단으로부터 우선 한국의 실태를 조사하고 장기적이고 포괄적인 연구 개발의 기본적 모형을 구안하려는 것이 본 연구의 목적이다.

연구의 한 단계로 전국 사범대학 과학교육 관계과나 전공을 대상으로 설문지 방법과 면담을 통해 학사 학위 및 중등 과학 교사 자격을 위한 최소 이수 학점 그리고 일반 및 과학 교육 관계 과목에 대해 조사하였다. 특별히 과학 교육 관계 과목에 대해서는 상세하게 필수 및 선택 과목 수와 학점, 대상 학생과 교수, 과목의 목표, 내용, 교육 자료와 평가 방법 등을 조사 분석하였다. 또한 설문의 두번째 범주인 과학 교육 과목 담당 교수의 중등 과학 교사 양성 교육 과정에 대한 일반적인 의견과 과학 교육 과목에 대한 구체적 의견을 종합 분석하였다.

이러한 실태 조사와 의견 분석을 바탕으로 과학 교육 과목의 총 이수 학점에 대한 비율, 과목수와 명칭 그리고 교육 내용의 기본적 사항을 제시함으로써 자료개발과 실제 지도를 위한 모형적 연구를 수행하였다.