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Exploring Secondary Science Teacher Preparation Program and Suggesting its Development Direction: A Case of USA and Korea

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Abstract: Teacher quality is a topic of international concern, as it impacts student learning and teacher preparation. This study compared the undergraduate secondary science teacher preparation programs from two universities in Korea with those of Oregon, USA. We examined the programs' structural curricular coherence, conceptual curricular coherence, and curricular balance. Structural curricular coherence was determined by examining the overarching goals of the institutions' programs, the organization of the programs of study in terms of meeting those goals, and outside bodies of evidence. All universities were in structural coherence for various reasons. Conceptual curricular coherence was determined by examining students' perceptions of the connection between their preparation and their clinical practice. In case of Korea, most students from both universities were not satisfied with their practical preparation. In the US, the students from both institutions felt well prepared to transition to inservice teaching. To determine curricular balance, we examined the institutions' preparation programs looking at the credit hours taken in the four main areas of the teacher knowledge base: GPK (General Pedagogical Knowledge), SMK (Subject Matter Knowledge), PCK (Pedagogical Content Knowledge), and CK (Contextual Knowledge). The total credit hours taken in each category was very similar by country but the application and field component in the USA was far greater than those of Korea where the focus was heavily on SMK and PCK. The main reason for these may be the nations' licensing and employment processes.

Keywords: teacher quality, teacher preparation program, inservice, preservice, curricular coherence

Introduction

Teacher quality is a topic of international concern, as an important factor impacting student learning is the quality of instruction (Darling-Hammond, 2000; Feiman-Nemser, 2001). In the words of the National Commission on Teaching and America's Future (1996), "What teachers know and can do makes the crucial difference in what teachers can accomplish" (p. 5). In the sciences, teacher quality is an especially critical issue. Wenglinsky (2000) found that student achievement was greater by 40% of a grade level when taught by mathematics and science teachers possessing a minor or major in their content area, which proves that teachers' content knowledge is pretty influential on students' achievement. In Korea, many reports also disserts that teachers who are trained and educated through professional development program showed high confidence in their teaching to impact students' achievement (Park et al., 2015; Park, 2014, Wright, Horn, & Sanders, 1997), which also indicate that teacher's expertise also improve students' achievement. Knowing and teaching is totally different. When teachers are qualitied high in content, they can be more effective in teaching when they are trained as follows; when teachers used to reflect on their teaching, they are willing to change their philosophy and teaching style, and when they are exposed to make trial and error in the real teaching context through sustainable interaction with helpers (like science

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educator as an expert) with the same purpose of improving teaching (Jeong et al., 2014; Lee et al., 2014; Wang et al., 2016). How can we know teachers are teaching well? Of course, teacher quality is linked back to teacher preparation programs.

The controversial report by the National Council on Teacher Quality (NCTQ) (Greenberg, McKee, & Walsh, 2013) has described teacher preparation programs in the United States as being partly responsible for the "educational decline" in American schools (p. 3). Park (2008) also reported that preserve teachers' field experience during preparation program was very critical in their forming beliefs and knowledge about science teaching and learning. It was implied that preservice teachers' experience in preparation program need to be chances where they form new beliefs and knowledge, they connect their theories into practices during field experience to lessen the gap between them, and more systematic preparation curriculums must be provided for the better quality of teachers (Wang et al., 2016). At this point, we can say it is very essential to provide good quality of teacher preparation program for teachers' expertise so that they can be equipped with abilities necessary to be qualified as the good teachers. How different are teacher education programs across the globe? By comparing those preparation programs internationally, we can learn those strength and weakness to develop preparation program more systematic for producing good quality of science teachers. For teachers' career, teacher preparation program is considered to be pivotal (Loveless, 2013; Otsuji et al., 2016; Wang et al., 2016).

A study edited by Ingersoll (2007) examined teacher preparation programs in six nations and one autonomous region; namely, Singapore, Korea, Japan, Thailand, Hong Kong, China, and the United States. That study looked more generally at teacher preparation. It focused broadly on items such as courses and degrees needed for licensure, entrance requirements into such programs, caliber of preservice teachers as compared to other candidates in other fields, as well as looking at the current teaching professionals to determine their level of qualifications and what number is teaching outside of their content area. The study stressed the importance internationally of teacher quality and the need for all students to be taught by qualified professionals. In contrast, this study was designed to take a deeper examination of the undergraduate secondary science teacher preparation programs of two different countries: Korea and the United States, specifically Oregon to provide concrete evidences showing how they look and how much they differ in their strengths and weakness. This makes for an interesting comparison as it examines a national program of study with a centralized set of outcomes, and different universities in Oregon each offering their own teacher preparation programs. In total, this study compared four programs: the undergraduate science teacher preparation programs from a public and a private institution in Korea with those of a public and a private institution in Oregon, USA. While the major components of teacher quality encompass knowledge, beliefs, and dispositions, we limited our comparison on preparation to the knowledge components; namely, contextual knowledge (CK), subject matter knowledge (SMK), pedagogical content knowledge (PCK), and general pedagogical knowledge (GPK) (Carlsen, 1999; Gess-Newsome, 1999; Grossman, 1990; Lee, 2013; Magnusson et al., 1999; Shulman, 1986, 1987). These will be viewed through the lenses of curricular coherence and balance (Feiman-Nemser, 1990; Hammerness, 2006; Tatto, 1996).

The purpose of the research was to explore secondary science teachers' preparation program to reveal its characteristics, on which to suggest its development direction for teachers' expertise. For this purpose, the research team decided to compare four undergraduate secondary science education programs from four different universities but two different countries and examine their similarities and differences in light of the cultural contexts in terms of teachers' expertise. It was hoped that by undertaking this comparison, we would gain information that would be useful to inform curricular changes and program improvements to strengthen undergraduate secondary science teacher preparation in both countries for teachers' expertise. The reason why we chose 4 different universities were to represent universities which produce preservice teachers in the unit of university type (private and public) from each country.

The significance of this study was to improve teacher preparation program for teachers' expertise on the basis of reformed based ways, with a solid grounding in both content and PK as well as with an ability to be effective with all students. This cross cultural study will highlight the improvement of teacher preparation program with the aim of balancing theories and practice for teachers' expertise. This study would be also the fodder for rich discussion of what components are critical with what balance between theories and practices (SMK, PCK, GPK, and CK) should be included in science teacher preparation program.

Methodology

Sampled universities

For the purpose of this study, we compared the undergraduate science teacher preparation programs of two different countries: Korea and the United States, specifically Oregon. One public and one private university from each country were sampled in the study. We investigated those preparation programs to see how much those programs are well developed to foster teachers' expertise. The universities selected for comparison comprise a sample of convenience; however, the programs at these four universities are representing as the fairly typical of their respective geographic areas. The programs from Korea represent a planned course of study governed by a more nationalistic approach to teacher preparation that impacts not only teacher preparation programs but also licensure and employment (Park, 2014). In contrast, Oregon, USA, has state standards but a more decentralized character in its preparation programs (AACTE, 2013). By selecting to include in our comparisons both a public and private viewpoint, we are sure that we would get a broader view of what teacher preparation looks like in these two culturally distinct countries. The two universities in Korea will be referred to as University A and University B. The two universities in Oregon, USA, will be referred to as University C and University D.

University A is a public college in a rural area located in the Northeast of Korea. The enrollment is approximately 15,000 students. The number of undergraduate students enrolled in the College of Education is approximately 1,000 students. University B is a private college in urban area located in the Southwest of Korea. The enrollment is approximately 20,000 students. The number of undergraduate students enrolled in the College of Education is approximately 1,200 students. Both University A and B have undergraduate and graduate program in their colleges of education. The undergraduate program offers science teacher preparation for secondary science teacher candidates only. A graduate program is provided for in-service science teachers and for science teacher candidates who graduated from department of science content major. These prospective teacher candidates are offered a teaching certificate as the master degree. Undergraduate and graduate endorsement areas include integrated science, biology, chemistry, physics, and earth science.

University C is a small, private, primarily undergraduate liberal arts college in an urban area in the Pacific Northwest. The enrollment is approximately 3,900 students. The number of undergraduate students enrolled in the School of Education is approximately 350 students. The School of Education offers a number of degree and certification programs: a four-year undergraduate program leading to a bachelor degree and teaching licensure; a one year (fifth year) master degree for career changers leading to an MAT degree and teaching licensure; a Masters of Education degree for inservice teachers; and a doctorate of education. In the sciences, undergraduate and MAT endorsement areas include integrated science, biology, chemistry, and physics. University D is a regional public liberal arts institution in a rural area of the Pacific Northwest. The number of undergraduate students is about 6,200. The College of Education has undergraduate and graduate education degrees. The number of undergraduate students enrolled in the College is approximately 325 students. The undergraduate teacher education program offers degrees resulting in teaching authorization licenses in Early Childhood, Elementary, Middle Level and High School. A part time and full time Master of Arts in Teaching (MAT) is offered to earn a teaching license for middle and high school levels and a master degree. The Masters of Science in Education, in Curriculum and Instruction, and in Information Technology are available as non-licensure graduate education programs. In science, undergraduate endorsement areas include biology, integrated science and chemistry while the MAT program adds physics to the list.

These two universities from each country are considered as representative teacher preparation institutes as public and private types of institutes but not representing on behalf of other teacher preparation institutes in Korea nor in USA for generalizing the results of this study.

Research procedure

As previously noted, because so much research has been done on teacher knowledge bases and because that resonates with curricular coherence and curricular balance, we chose to study our preparation programs through those lenses. We examined the articulation between what we know to be the identified components of the teacher knowledge base and the components of our undergraduate science teacher education programs. Specifically, we looked at each program for structural and conceptual curricular coherence; that is, how well the curriculum match the program's stated goals and how adequately students perceive their curriculum training prepared them to be an effective teacher for their expertise. Then we looked at curricular balance; that is, how well the curriculum integrates the theory and practice of teaching, balancing studies at university classrooms and fieldwork at schools. On the basis of this assumption, we decided to collect the data as follows.

Data collection

To explore the characteristics of teacher preparation program, we checked two different coherences; one is 'structural coherence' which can be explored by external evaluation documentations where we can see the scope and policy of teacher preparation program for their expertise. The other one is 'conceptual coherence' which can be explored by students' understandings through survey, questionnaire, or interviews. Lastly, we check the curricula balance among 4 different knowledges, GPK, PCK, CK, and SMK. More details are as follows.

Structural coherence: Structural curricular coherence is often determined by examining the correspondence between the overarching goals of the institutions' programs and the organization of the programs for study in terms of meeting those goals (Hammerness, 2006; Oliva, 2011). To best determine if the programs from the four institutions had curricular coherence and to avoid personal bias, we relied heavily on the determination of external bodies for the evaluation. For Korean institutions, the coursework undertaken by preservice teachers is governed by the Teacher Certification Authorization Act. For the Oregon universities of USA, we relied on *National Council for Accreditation of Teacher Education* (NCATE)/ Council for the Accre-ditation of Educator Preparation (CAEP) accreditation and documentation.

Conceptual coherence: Students' perception on their preparation program can help in conceptualizing how science teachers could be prepared (Micha et al., 2015; Simmons et al., 1999). Based on this premise, conceptual coherence was determined by examining students' perceptions of the correspondence of what they were learning and what they were expected to do in their clinical practice.

To determine student perceptions, different methodologies were employed for two countries. In Korea, a questionnaire consisting of both Likert-type and open-ended questions was used to elicit the participants' view on the curricular coherence of their program (Appendix A). This instrument was designed by the research team based on work by Tairab (2008) and checked in content by cross checking. A portion of the questionnaire used a 5-point scale (from highly prepared to not prepared at all) to determine the perceived value of four components of teaching competencies (plan and prepare for teaching, design effective teaching environment, execute teaching activities, and model professional practices) as developed by Tairab (2008) and grounded in Danielson's model of teaching (2002). Additionally a 4-point Likert-type scale (too much time, sufficient time, very little time, too little time) was used to ascertain students' perception on the balance of time allocation for nine elements identified by Tairab (2008) that make up the teacher preparation program. Means and standard deviations for each category will be computed and t-tests used to compare the students' perceptions from University A and B. An open-ended questionnaire was designed to determine the students' perceptions of four knowledge areas (GPK, CK, SMK, and PCK) of the teacher preparation program. The student responses were read and coded as relating to the four knowledge areas and analyzed for overall perceptions. The questionnaires were administered to volunteer senior grade preservice science teachers of University A and B during their science methods class.

In University C and D, the number of preservice teachers preparing to be endorsed to teach science is too small to allow for the use of a similar questionnaire. Alternative methods were used to determine conceptual coherence. The School of Education in University C has an external program advisory board, Consortium for Educational Advisement and Development (CEAD), comprised of public and private school administrators, alumni, current students, and faculty from the School of Education and other units on the campus. All undergraduates and graduate students completing a teacher preparation program participate in exit surveys each year. Additionally, about half-dozen students from each program are randomly selected and take part in focus interviews with a CEAD member to provide the Consortium with data they use to advise the School of Education as to the effectiveness of the programs from the students' perspectives. Students respond to six interview questions (Appendix B). Surveys and interviews are conducted during a class session at the end of the final semester of the program. The CEAD reports for the past year provided undergraduate student perception data. While the pool of respondents included all secondary undergraduates and not just those preparing to teach science, because the bulk of the teacher preparation program is consistent across all content areas (differing only in specific content area and methods courses), there is no reason to believe any one group of students would feel differently from the others. In University D, all undergraduates completing a teacher preparation program take an exit survey about their perceptions of their preparation to become licensed teachers. While it is possible to look at specific responses to science content and pedagogy across all

Table 1. The kinds of knowledge and its definition for curricular balance (David et al., 2015; Lee, 2013; Magnusson at al., 1999; Shulman, 1986; 1987)

Knowledge	Operational definition in this study
General Pedagogical Knowledge (GPK).	These are basic pedagogy courses, taken by all teachers regardless of content or level. Examples of these courses include: Introduction to Education, Psychology of Education, Special Education, Assessment, and Classroom Management.
Subject Matter Knowledge (SMK).	These are content specific courses that increase students' knowledge in the sciences, such as Modern Physics, General Chemistry, Educational Inquiry in Earth Science, and Plant Taxonomy and Laboratory.
Pedagogical Content Knowledge (PCK).	These are courses that are designed to help a student learn the teaching approaches specific to a particular content. These courses include: Science Content Methods, Multimedia in Science Education, Instructional Methods and Teaching Materials in Science, Curriculum and Educational Evaluation of Science.
Contextual Knowledge (CK).	Contextual Knowledge Courses are those that help students *apply* their learning to actual classes; they learn how to adapt their instruction to specific contexts. Example classes include: Student Teaching, Student Teaching Seminar.

levels, the secondary science student teachers data cannot be separated from the rest. As with University C, there is no reason to expect any one group would have different beliefs than any other due to the similarities in undergraduate programs.

Curricular balance: To determine curricular balance, we examined the preparation programs at each of the institutions for the amount of credits taken in the four main areas of the teacher knowledge base. Specifically, we assigned coursework as follows (Table 1).

Data analysis

For data analysis in structural coherence, the researchers in a team share the ideas from teacher preparation program documents as external evaluation and discussed what they mean to reveal explicit characteristics of teacher preparation program. For data analysis in conceptual coherence, the researchers analyzed the data from surveys and questionnaires with interviews to reveal its characteristics through t-test and coding system. For data analysis in curricular balance, the researchers checked and compared credits students take in 4 different knowledges to decide how much credits are balanced for teachers' expertise in each country. If there was any disagreement about the category for any particular course, additional sources like syllabi were examined, differences were discussed, and a final consensus was made by the researchers to construct the validity and its reliability of data analysis.

Results

Structural coherence

Both of the Oregon selected universities have *National Council for Accreditation of Teacher Education* (NCATE)/Council for the Accreditation of Educator Preparation (CAEP) accreditation. According to the most recent NCATE Unit Standards (2013), each unit must have a conceptual framework that is "knowledge-based, articulated, shared, coherent, consistent with the unit and/or institutional mission, and continuously evaluated" (NCATE.org). Thus, receiving NCATE accreditation necessitates the existence of evidence-based curricular coherence; it was determined that both Oregon programs had structural curricular coherence. Similarly, two selected Korean institutions must meet national standards and examination requirements, as well as follow the guidelines of the Teacher Certification Authorization Act. First of all, the curriculum was designed to equip preservice teachers with knowledge connected to practices, which are linked to the content of national teacher employment test for Teacher Certification Authorization Act. Preservice teachers take more than 140 credits for 4 years from freshman to senior in the course of GPK, SMK, PCK, and CK and then they take national test to be teachers after graduating from universities (Wang et al., 2016). Overall, the researchers in this study agreed that preservice teachers from all selected universities in Korea as well as USA take courses, the stated mission of which include preparing preservice teachers with abilities in teaching science in terms of GPK, SMK, PCK, and CK, which are also evaluated in different ways according to the context of countries.

Conceptual coherence

Student perceptions were used to help determine conceptual coherence. For Universities A and B from Korea, data were received through student questionnaires. University C (private Oregon University) relied on CEAD data. University D (public Oregon University) relied on data from the most recent graduating student exit survey.

For Korean universities, Table 2 shows the perceived value of four components that make up teaching competencies. A t-test showed, there was no significant difference in student perceptions between university A and B ($p > .05$). The participants of University A and B felt that they had been "adequately prepared" to teach science. The majority of participants expressed relatively higher confidence in "plan and prepare teaching" and "execute planned and prepared teaching activities" components compared to the other two components. This is thought to be due to a large amount of PCK related courses. With regard to

Table 2. Mean and standard deviation of University A and B preservice teachers' perceptions of adequacy of meeting teaching competencies (scale of 1-5, low to high)

Components	University A (n=20)		University B (n=22)	
	M	SD	M	SD
Plan and prepare teaching (7 items)	3.64	0.93	3.36	1.06
Design effective learning environment (6 items)	3.01	0.97	3.11	1.08
Execute planned and prepared teaching activities (11 items)	3.31	1.03	3.47	1.05
Model professional practices (6 items)	2.47	0.86	2.82	1.13
Total (30 items)	3.16	1.04	3.24	1.10

Table 3. Mean and standard deviation of Korean preservice teachers' perceptions of time balance in their program (scale of 1-4, low to high)

Elements	University A (n=20)		University B (n=22)	
	M	SD	M	SD
1. Time to study subject matter knowledge	2.85	0.36	2.86	0.36
2. Time to study educational theories and principles	2.90	0.54	3.00	0.63
3. Time to study methodologies of teaching	2.90	0.44	2.81	0.68
4. Time to study classroom environment and management	1.80	0.75	1.76	0.62
5. Time to study student assessment and evaluation	2.00	0.63	2.05	0.74
6. Time spent in school visits	1.75	0.70	1.71	0.56
7. Time spent in microteaching	2.05	0.74	2.38	0.86
8. Time for teaching practice in schools	2.10	0.70	2.33	0.86
9.Time for field and practical work	2.20	0.75	1.90	0.89

"model professional practices" component, participants show low confidence. This may be due to a small number of CK related courses, which include micro-teaching course or field experience (only 4 weeks at senior year). There had been reports that field experience as practicum, where preservice teachers had chance to reflect on their theories and practices to be connected each other, has been considered as one of limiting factors in that preservice teachers do not have enough time to observe cooperative teachers' teaching, form understandings about students, and practice their teaching to notice dissonance between theory and practices (Kwak, 2009; Park, 2008; Wang et al., 2016; Yoon et al., 2013).

Table 3 shows the participants' view on the balance of time between various elements that make up their teacher preparation program. Again the perceptions of students at University A and B were very similar. Participants perceived that the time allocation of theoretical knowledge (element 1, 2, 3) is sufficient, while that of practical knowledge (element 4-9) is deficient. Especially, participants felt that "very little time" was allocated to "school visits" and "classroom environment and management" elements, whose result supported those of other researches, releasing that insufficient field experience could make preservice teachers have less self-esteem and efficacy in their teaching science (Lee, 2013; Park, 2008). This result supported other researches illustrating the gap between theory and practice in preservice and beginning teachers who experience the dissonance at real teaching context when exposed (Kwak, 2002; Park, 2010; Roehrig & Luft, 2008).

Table 4 shows a summary of participants' responses (20 from A and 22 from B University) to the open-ended questionnaire. The majority of the Korean students perceived an unbalance between theory and practice, and also expressed dissatisfaction with the lack of a more intense field component.

In University C, based on the CEAD reports, students consistently responded that they feel well prepared to transition from preservice to inservice teaching (Table 5). From the focus group responses, it was noted that the students specifically credited their

Table 4. Summary of responses to open-ended questions from Korea respondents

Category	University A		University B	
	Positive	Negative	Positive	Negative
SMK	• enriched learning for secondary school curricula content • helpful to answer students' in-depth questions	• most of them do not seem too helpful because of the different level from secondary school curricula content	• addresses students' various and creative questions • can understand the developmental processes of content through history of science • experiencing a variety of experiments and use of materials	• lack of relevance to secondary school science
PCK	• applying various teaching-learning model and strategies to actual school curriculum • direct help to prepare and execute science lesson • microteaching and feedback according to actual school curriculum • perform inquiry activities of secondary school science	• philosophical background and theory are not very helpful • the lack of information relating to real class operation	• recognizing a direction of exemplary teaching through learning theory • microteaching and feedback according to actual school curriculum • acquisition of teaching methods specific to science subject • recognizing topic-specific teaching methods • perform inquiry activities of secondary school science	• lack of connection between theory and practice • lack of field applicability because theory-oriented • inquiry contents apart from the secondary school curriculum
GPK	• overall understanding of teaching profession and education • understanding and guidance for students	• not help in science class due to theory-oriented • courses for teacher employment exam.	• provide comprehensive information and knowledge of teaching profession and education • understanding and guidance for students	• plenty of overlap with content pedagogy courses • lack of field applicability; too theoretical
CK	• attend and observe in-service science teachers' class • teaching practice and feedback • student counseling and guidance • experience the real atmosphere of the school	• write journal of teaching practicum • few opportunities to teach, moreover the term is too short	• attend and observe in-service science teachers' class • teaching practice and feedback • understand students through experiencing classroom advisory teacher • experience overall school life	• few opportunities to teach, moreover the term is too short

sense of preparation to the extensive field experience they complete, their training with working with diverse population and the "push" to be "extremely reflective" (where preservice teachers interact with students, cooperative teachers, and peers, which make them reflect on theories which they learn at campus) about their experiences. Based on the CEAD data and summary, the students' comments suggest that the program at University C demonstrated conceptual coherence.

In University D, graduating teacher candidates were asked to complete an exit survey anonymously. Each content area had two questions and there were also several questions about their ability to teach content in general. Table 6 represents student survey data from all teacher candidates from the exit survey from the most recent undergraduate cohort. The results indicated that students felt that they have sufficient science content background (SMK) and feel prepared to science teach content (methods of teaching science: PCK). However, the science results are lower than how they feel about teaching in content areas in general.

Table 7 shows the results of the survey items that pertain more to conceptual knowledge balance (CK). The data suggest that the program at University D demonstrated conceptual coherence.

Table 5. Mean and standard deviation of University C preservice teachers' perceptions of time balance in their program (scale of 1-5, low to high)

To what degree are you better able to apply the following ideas than you were when you began your teacher preparation program (1=a little better to 5=a great deal better)	M	SD
Accommodating diverse ideas about education.	4.7	0.45
Being self-directed in solving problems related to your work.	4.4	0.97
Respecting students and their families.	4.6	0.73
Applying diverse modes of communication in your work.	4.3	0.93
Seeking multiple viewpoints	4.4	0.87
Learning about the diversity of schools and communities in which you work.	4.6	0.89
Understanding the relationship between schools and the larger society.	4.6	1.09
Applying connections between academic disciplines and your teaching.	4.5	0.62
Understanding how knowledge is constructed in your academic discipline.	4.3	0.89
Using developmentally appropriate strategies in your teaching.	4.4	0.81
Applying diverse instructional strategies to accommodate the needs of learners.	4.3	0.95
Designing lessons that help students make connections to the larger world.	4.2	0.81
Using educational technology to improve student learning.	3.8	1.64
Developing your own educational vision.	4.4	0.81
Implementing your educational vision in classrooms.	4.4	0.89

Table 6. University D preservice teachers' perceptions of their knowledge of science content, ability to teach science and content areas in general (scale of 1 to 4, low to high) (n=75 unless otherwise noted)

By the end of your full time student teaching, how prepared were you in the following areas? (1=Emerging, 2=Developing, 3=Proficient, 4=Advanced)	M	SD
Science content (n=67)	2.84	0.51
Methods of teaching science (n=67)	2.81	0.50
Use assessment strategies most appropriate to your content area	3.17	0.53
Use instructional strategies most appropriate to your content area	3.07	0.47
Locate and use resources appropriate to your content area	3.12	0.57
Design lessons/units aligned with content standards in your area	3.24	0.52

Table 7. University D preservice teachers' perceptions of abilities and understanding as a result of their program (scale of 1to 4, low to high) (n=75 unless otherwise noted)

By the end of your full time student teaching, rate your ability to: (1=Emerging, 2=developing, 3=Proficient, 4=Advanced)	M	SD
Teach all students effectively. (7 items) n=77	2.93	0.60
Adapt/modify/differentiate curriculum/assessment/and instruction to meet the needs of all learners.	3.01	0.58
Use your understanding of learning and development to maximize teacher effectiveness.	3.05	.46
Align curriculum, assessment, and instruction with the needs of learners and the demands of the setting.	3.02	0.52
Analyze and reflect upon your teaching and student learning.	3.33	0.6
Align your philosophical beliefs and values as a teacher with your actions.	3.25	0.64
Use the skills and dispositions of researchers to explore/solve problems in your classroom and schools.	2.81	0.51
Plan and use technology to support teaching and learning.	3.01	0,53
Plan and use successfully a variety of instructional methods.	3.05	0.49

Curriculum balance

Table 8 shows the results of comparison between Korea and Oregon, USA, in terms of four categories for teacher knowledge base. The number of semester credit hours taken in each of the four categories was very similar by country. However, when comparing them of USA and Korea, we found that while all four programs were similar in GPK (~19); for CK, USA had 3 times the coursework (12 v. 4); for PCK, USA had 3 v. 20 in Korea; and for SMK, USA had 40 v. 65 in Korea. In our discussions about these comparisons, we realized that the application and field

Table 8. Comparison of the number of semester hours in each of four teacher knowledge base categories in selected universities in this study

			GPK	CK	SMK	PCK	Total
Korea	Univ. A (S.H)	Physics	18(14)	4	62(27)*	22(10)	106
		Chemistry	18(14)	4	66(18)	18(10)	106
		Biology	18(14)	4	69(27)	15(10)	106
		Earth Science	18(14)	4	66(25)	18(10)	106
		Integrated Science	18(14)	4	35	17	74
	Univ. B (S.H)	Physics	18(14)	4	77(43)	14(6)	113
		Chemistry	18(14)	4	76(41)	14(6)	112
		Biology	18(14)	4	76(37)	14(6)	112
		Earth Science	18(14)	4	70(34)	14(6)	106
		Integrated Science	18(14)	4	42	8	72
Oregon	Univ. C (S.H)	Physics	21	12	42(5)	3	78
		Chemistry	21	12	40(12)	3	76
		Biology	21	12	37(10)	3	73
		Integrated Science	21	12	20(8)	3	56
	Univ.D+ (S.H)	Biology	18	13.3	46.7(12.7)	4	82
		Integrated Science	18	13.3	42.7(13.3)	4	78

*( ): denotes number of program courses that are electives
+University D's credits were converted from Term Hrs to Semester Hrs

component in USA was far greater than in Korea where the focus was heavily on SMK and PCK (Abell, 2006; Cannon & Scharmann, 1996; Lee, 2009).

Discussion

We explored the characteristics of secondary teacher preparation program in each country, Korea and USA, for the purpose of suggesting its development direction for teachers' expertise. Undergraduate secondary science student teaching requirements vary widely between the two countries. This may be due primarily to licensing and employment issues. In USA, in the case of Oregon, the state licensing body approves the institutions' programs, but licensing is separate from graduation. However, being certified in Korea does not mean the teachers can seek employment; rather, the certified science teacher candidates are now qualified to take the Teacher Employment Examination (TEE) in each subject area. Each test is weighted toward measuring SMK, with less reliance on questions concerning CK, PCK, and GPK. This is why Korean teacher preparation program curriculum consists of strong focus on SMK, which can easily be checked in the exam offered annually and this is the 1st phase of entry into employment opportunities (Wang et al., 2016). In the 2nd phase, candidates who pass the 1st test can take interview as well as demonstrate their teaching, which are less weighted when compared to that of SMK in the 1st phase. This different employment system for secondary science teachers in each country influence current science curriculum and instruction of preparing teacher program at university in two countries. This system of each employment from countries can make the following comparison.

We found the universities' programs were very similar within the same country but had obvious differences when comparing cross-country. The following similarities among the programs were noted: (1) each program of study has structural coherence-it is designed to meet the outcomes/goals for teachers' expertise set by the institution; (2) courses on subject matter, pedagogical preparation, and contextual preparation are included in all programs; (3) some kind of standardized examination is required of teacher candidates; (4) semester hours of GPK is similar across all 4 institutions; (5) the intra-country universities are very similar across all 4 teacher knowledge base categories.

In contrast, the following differences were discerned: (1) Korean programs stress SMK and PCK much more than the Oregon (USA) institutions; (2) Oregon, USA, programs have more CK than the Korean programs: in Korea, field experience as practicum lasts only for four weeks, unsupervised, with no set requirement for "solo teaching;" in Oregon, student teachers have varying levels of field experiences throughout their four year program, including supervised student teaching consisting of at least 15 weeks with a minimum of 9 weeks of "solo teaching."

We suggest the main reason for the these differences lies with licensing and employment differences; for example, the TEE of Korea is heavily focused on subject matter knowledge while the licensing body in Oregon, USA, requires a teacher work sample and specifies amount of "solo" teaching with supervision. Preservice teachers from universities in Oregon, USA, observe the cooperative teachers' teaching enough before exposed to the teaching context, interact with peers, and cooperative teachers for their teaching experience. While observing, preservice teachers could have a chance to know better about students, which promote teachers' understandings about PCK. Preservice teachers consider peer's interaction as one of most critical influential factor improving their teaching and understanding in their career as teachers. In addition, cooperative teachers with whom preservice teachers keep interacting are also pivotal factor in their teaching expertise (Borko & Mayfield, 1995; Park, 2008). For individual teaching portfolio through solo teaching, supervisor assigned to each preservice teacher is considered as the critical factor in her/his improving teaching in the classroom. However, field experience period is very short when compared to that of USA, and we do not have supervising system, or cooperative teachers, if any, cannot concern much about preservice teachers' assigned teaching time. This is worse in case of private university. Each preservice teacher from private university of Korea should find the school where he/she is attending for 2 credit hours of experience (4 weeks). What is worse, there is a few presrvice teacher who cannot teach at all during field experience. Basically preservice teachers do not have enough time of teaching and some of them cannot teach at all but observe the class. Based on student responses from both countries, preservice teachers appreciate spending time in actual classes and appreciate college classes that meld theory and practice.

At this point, in case of Korea, it can be concluded that more intensive course for CK must be offered so that preservice teachers could try and error their theories in the practical teaching context, to feel dissonance, and to form systematic understanding about teaching to be improved by lessening the gap between theory and practice. In addition, more structured supervising system for preservice teachers' expertise are recommended, which must be strongly connected to the content of TEE. Since there had been claims that the system of TEE must be changed to screen good quality of teachers, we need to have more weight in scores of teaching demonstration and developing lesson plan connected to the contextual knowledge. Again, CK can be enhanced by providing chances for preservice teachers to be exposed to teach at real site through field experience through the interaction with cooperative teachers and supervisors. In case of Oregon, there were practicum of one year where preservice teachers interact with supervisors who help preservice teachers form/change scientific concepts correctly and reflect on their teaching practices from their theories, which equip them with abilities of teaching to be professional. We need to focus on teachers' expertise in GPK, PCK, CK, and SMK. But we need to be sure of alignment between TEE and teacher preparation program to provide good quality of science teachers. Then we should try to lessen the gap between theory and practice from these all different knowledges by providing real teaching context through microteaching and field experience. From these points, it is recommended that we look through the system of TEE and teacher preparation program with the more emphasis of contextual knowledge. Lastly, we should look through the system of TEE to see if this is pretty appropriate to measure teachers' competencies for their expertise.

This study is a preliminary work. It has many limitations including a small sample size, a focus only on published program (not looking at enacted curriculum, which is a limitation in the examination of conceptual coherence). Additionally, we did not look at the quality of teacher candidates graduating from the four institutions. We also did not consider non-education courses in the program and their possible impacts on teacher preparation. Although the four researchers reviewed the sorting of courses, these are our interpretations of assigning courses to categories often based on course descriptions and syllabi v. direct instruction of the class, which were various data sources. But we as a research team continuously discussed to understand different educational system in teacher preparation program for its validity and reliability.

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Appendix A

Student Questionnaire to Measure Student Perceptions-University A and B

Responded using a Likert-type scale of 1-4, low to high, on how well their program prepared them:

Plan and Prepare for Teaching

1. To demonstrate knowledge of content and pedagogy in the specialist subject
2. To demonstrate knowledge of student characteristics
3. To demonstrate knowledge of interest, learning styles and culture
4. To demonstrate knowledge of how to select learning outcomes for students
5. To demonstrate knowledge of how to select and use appropriate resources
6. To demonstrate knowledge of designing coherent instruction in terms of selection of appropriate activities, instructional materials, and group formation
7. To demonstrate knowledge of assessment and evaluation techniques appropriate for students.

Design Effective Teaching Environment

8. To demonstrate knowledge of how to create classroom environment of respect and rapport
9. To demonstrate knowledge of how to establish a culture of effective learning
10. To demonstrate knowledge of classroom management procedures when managing instruction, materials, and students
11. To demonstrate knowledge of how to organize the physical classroom space
12. To maintain interest and motivation of students
13. To handle classroom discipline problems

Execute Teaching Activities

14. To demonstrate knowledge of using appropriate language for communication with students both in written and oral format
15. To demonstrate knowledge how to use appropriate questioning techniques
16. To demonstrate knowledge of how to engage students in learning
17. To demonstrate knowledge of how to provide feedback to students
18. To demonstrate knowledge of how to adjust instruction to suit student needs when appropriate
19. To be able to reflect on and be critical of development as a science teacher
20. To demonstrate knowledge of how to assess and record student progress
21. To use teaching strategies appropriate to age, ability and level of students
22. To be aware of social, psychological, and cultural differences among students
23. To present concepts in clear and appropriate language to students
24. To use and implement technology in teaching and learning

Model Professional Practices

25. To communicate with parents, and officials about curriculum and other educational matters that concern student learning
26. To understand professional responsibilities
27. To demonstrate knowledge of how to contribute professionally to schools and educational zones

28. To develop effective working relations with colleagues
29. To demonstrate knowledge of how to be proactive in serving students, parents, and other community members
30. To demonstrate knowledge of how to make professional decisions on matters related to work

Open-ended Questionnaire

1. In your teacher preparation program, what courses of SMK, PCK, PK respectively are helpful in executing your science teaching? Explain why they were helpful.
2. In your teacher preparation program, what courses of SMK, PCK, PK respectively are not helpful in executing your science teaching? Explain why they were not helpful.
3. What are the challenges to reform courses of SMK, PCK, PK respectively in your teacher preparation program?
4. In your teacher preparation program, what aspects of teaching the practicum were helpful in executing your science teaching? Explain why they were helpful.
5. In your teacher preparation program, what aspects of teaching practicum were not helpful in executing your science teaching? Explain why they were not helpful.
6. What are the challenges to reform teaching practicum in your teacher preparation program?

Appendix B

Interview questions for graduating undergraduate secondary teacher candidates in University C

1. Do you feel ready to graduate?
2. Are you ready to transition from being a college student to becoming a professional educator?
3. Are you prepared to seek an initial teaching position?
4. How has this program prepared you to be a successful educator?
5. What values will you take with you after graduation?
6. Is there any aspect of your teacher preparation program that could have been adjusted to more adequately prepare you to assume your teaching responsibilities?
7. What do you value most about the education program at (this institution)?