



# Physics Teacher Knowledge Aimed in Pedagogical Studies in Finland and in South Korea

Heidi Krzywacki

University of Helsinki, FINLAND

Byeong-Chan Kim

Kyung Hee University, Seoul, SOUTH KOREA

Jari Lavonen

University of Johannesburg, SOUTH AFRICA & University of Helsinki, FINLAND

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## ABSTRACT

This paper analyzes the pedagogical studies of Finnish and South Korean physics teacher education programs that guide teacher educators to support student teachers' to build readiness for acting as professional teachers in a secondary school classroom. Research on the domains and origin of teachers' professional knowledge provides a framework for analyzing the programs and the potential support of the program for becoming a professional teacher. First, the aims of the pedagogical studies are categorized, resulting in ten themes that characterize the programs. Second, the programs are analyzed in the framework domains of teacher knowledge and the origins the knowledge is suggested to learn. The domains of knowledge include the knowledge needed in consuming and producing educational research, general pedagogical knowledge, and pedagogical content knowledge. Distribution among the four domains of teacher knowledge varies in Finnish and South Korean programs, reflecting the differences in the national education cultures. Pedagogical studies in Korean physics teacher education are more theoretically oriented than their Finnish counterparts. However, the Finnish and Korean programs do bear similarities, such as an emphasis on reflection and a research orientation, as a part of their pedagogical studies.

**Keywords:** physics teacher education, secondary school physics, teacher knowledge

## INTRODUCTION

Finnish and South Korean (henceforth, simply "Korean") science education have received interest from teacher educators, researchers, journalists, and education policymakers all over the world since the release of the first Programme for International Student Assessment (PISA) results in 2002. This interest is a consequence of the results (ranking among countries) achieved by Finnish and Korean 16-year-old students in PISA Science (OECD, 2007; 2010). Teacher education, as well as teacher quality, has been regarded as one of the reasons behind the

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**Correspondence:** Jari Lavonen, University of Johannesburg, South Africa & University of Helsinki, Finland

✉ [jari.lavonen@helsinki.fi](mailto:jari.lavonen@helsinki.fi)

### **State of the literature**

- Not only domains of teacher knowledge but also origin of knowledge matter in teacher education
- Teacher students learn from practice but reflection is an essential part of learning process

### **Contribution of this paper to the literature**

- It is possible to produce high quality teachers with different teacher education programs
- Teacher education is embedded in a particular societal and cultural context that needs to be taken into consideration while comparing and developing the programs

students' good performance (Darling-Hammond, 2000; Rockoff, 2004) although, for example, the socio-economic status of the school district and classroom size do make this relationship complex (Nye, Konstantopoulos, & Hedges, 2004).

Auguste, Kihn, and Miller (2010) analyzed teacher education in Finland and Korea in order to identify good teaching practices and the influence of teacher education on PISA results. According to their findings, successful recruitment procedures and the cultural respect for teachers set solid grounds for high-quality teacher education and quality of teachers. In both countries, teachers are educated at university level programs. However, Auguste and colleagues (2010) did not conduct a careful analysis of the content and structure of the teacher education programs. Although, the culture and traditions of education are different and the comparison of two very different programs is challenging, we decided to compare the pedagogical studies of physics teacher education programs at one Finnish and one Korean university, both of which were located in their capital cities. Because of the differences in context and history of education, we avoid making heavy conclusions and suggestions for other contexts (Lederman & Lederman, 2015).

Our aim is to discuss and compare pedagogical studies of physics teacher education programs in Finland and Korea by analyzing intentional instruction agendas or curricula. The analysis of curricula has been an important area of education research (e.g., Carlsen, 1999; Grossman, 1990; Hashweh, 2005). Even if curriculum analysis hardly provides information about actual practice and the hidden curricula of teacher education as such, it is important to discuss the outlines of teacher education programs that teacher educators follow while making decisions concerning instructional practices, content, and learning materials, as well as student assessment. In addition to the domains of teacher knowledge, the origins of teacher knowledge is essential for elaborating how teacher knowledge is designed to accumulate over the courses and teaching practices of a teacher education programs.

This paper addresses the question: *How do pedagogical studies, as part of physics teacher education, aim to build student teachers' knowledge in Finland and Korea?*

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## TEACHER KNOWLEDGE

The framework for analyzing the Finnish and Korean teacher education programs is based on the domains and origin of teacher knowledge views. However, from the students' perspective, contents and activities related to separate knowledge domains and the origins of this knowledge intertwine in the implication of the program; the latest occurs in teaching practice when student teachers assume the teacher's role in the classroom.

### Domains of Teacher Knowledge

The structural analysis of teacher knowledge and the classification of teacher knowledge domains provided here are a framework for comparing the pedagogical studies of physics teacher education programs in Finland and Korea. A well-known approach for describing a teacher's knowledge base dividing it into subject-matter (content) knowledge, pedagogical content knowledge (PCK), and general pedagogical knowledge (GPK) (Carlsen, 1999; Gess-Newsome & Lederman, 1999; Grossman, 1990; Hashweh, 2005; originally based on the work by Shulman, 1986, 1987). We follow this simple model of teacher knowledge in our analysis, even though the original model has been augmented; for example, Gess-Newsome and Lederman (1999) introduced teachers' *contextual knowledge* and defined it as knowledge of the context of teaching. However, the simple model better works in our study because we will analyze teacher education programs where the sentences are short and lack context.

*Content (subject matter) knowledge* constitutes a knowledge domain related to expertise in a particular subject, such as physics. It includes conceptual and procedural knowledge in the given domain. Furthermore, a teacher needs to understand the nature of knowledge – that is, the epistemological and ontological aspects of the subject. However, content knowledge is not the focus of this research.

*Pedagogical content knowledge (PCK)* is a knowledge domain that distinguishes teachers from other subject specialists (Carlsen, 1999; Shulman, 1987). PCK is the synthesis of all knowledge needed for the teaching and learning of a certain topic (Grossman, 1990). Thus, it is always related to subject-matter knowledge (see e.g., Grossman, 1990; Nilsson, 2008). According to Gess-Newsome (1999), the following areas have been associated with PCK: (1) teaching or instructional strategies, assessment strategies, and collaboration strategies; (2) knowledge about student interest, motivation, and the learning of conceptual and procedural knowledge and skills; (3) knowledge of science learners, like student thinking, misconceptions, and cognitive and affective demands of tasks and activities; (4) knowledge about resources available to support teaching and learning; curriculum knowledge and goals for student learning (see also Abell, Rogers, Hanuscin, Lee, & Gagnon, 2009). When a teacher employs PCK in the planning and implementation of a lesson, he is focusing on a question that he wants students to be able to answer, and how he facilitates the development of student understanding. In European tradition, especially in Germany, France, and the Nordic countries including Finland, the term “didactics,” or more precisely, “didactical

transformation" (in German, *didaktische Transformation*), is associated with processes similar to those discussed under the PCK domain (Kansanen, 2002).

The third main category of teacher knowledge is *general pedagogical knowledge* (GPK) (Gore & Gitlin, 2004). It has a special reference to broad principles and strategies of classroom management and organization that appear to transcend subject matter. Hativa, Barak and Simhi (2001) proposed that GPK includes pedagogical principles and classroom strategies with no relation to subject matter. Morine-Dersheimer and Kent (1999) argue that general pedagogical knowledge consists of the following general knowledge areas related to pedagogy: (1) classroom management and organization, (2) instructional models and strategies, and (3) classroom communication and discourse.

Basic academic competencies, such as research skills, are not emphasized in the original knowledge domains introduced by Shulman (1986, 1987). However, for example, the "teacher leadership" movement emphasizes teachers as consumers of research-based knowledge in order to be able to act as curriculum specialists (Harris, 2003; Lieberman, 1992 ;). In both the Finnish and Korean traditions, teachers are regarded as autonomous academic professionals who are both consumers and producers of educational research knowledge (Jakku-Sihvonen & Niemi, 2006; Kim, B. C., 2001). Therefore, in the context of Finnish and Korean teacher education programs, one knowledge area should be included in the model of teacher knowledge: knowledge or competence to consume and produce educational, research-based knowledge.

### **The Origins of Teachers' Knowledge**

The origin of teacher knowledge is connected to the dilemma of the "way of knowing." In a form of a question, we can conceive of it as "From where does teacher knowledge arise?" Here, we follow Hiebert, Gallimore, and Stigler (2002), who distinguish practical and professional knowledge in order to describe the ends of the continuum regarding the origin of teacher knowledge (see also Cohen, 2008; Korthagen, 2007; Pendry & Husbands, 2000).

Professional knowledge is built on research-based, scientific information on teaching and learning; furthermore, it is characterized by its generalizability and scientific character. Students become familiar with this knowledge by utilizing research literature and carrying out small-scale educational research projects. Gitlin and colleagues (1999) state that student teachers' conceptions of research should form the basis for research-based teacher education and pave the way for making research a part of teacher education. One possibility is combining research activities with practical experience through a research project completed as part of teaching practice (Brinkman & van Rens, 1999). This would also serve to strengthen the skills needed for professional development and lifelong learning. However, since student teachers only partly understand what an authentic research process is like, it is challenging to provide research-based knowledge in a form that is easy for them to utilize. Cohen (2008) elaborates on the learning process, noting that it requires both consuming and producing educational knowledge (see also Pendry & Husbands, 2000).

Hiebert and colleagues (2002) identify three essential features of teachers' practitioner knowledge: (1) it is linked with practice and grounded in a real-life context, addressing specific problems related to processes that really exist in the classroom; (2) it is specific, detailed, and concrete; (3) it is integrated, meaning that it is linked with practice and organized by the particularities of practice. Van Driel and colleagues (2001) conceptualize experienced teachers' practical knowledge as action-oriented and person-bound. This knowledge integrates experiential knowledge and formal knowledge with personal beliefs. Since physics student teachers hardly have any teaching experience before their initial teacher education courses, it is not easy to adopt strategies such as peer coaching or collaborative action research, which can be quite valuable when employed as a part of in-service teacher education.

It is possible to transform practitioner knowledge into professional knowledge through special procedures and activities organized and supported in teacher education. The idea is to make teacher knowledge public and commonly shared and, consequently, to support student teachers' learning from their experiences. Hiebert and colleagues (2002) emphasize that, in order to fulfill the requirement of taking place in the public domain, the representation of knowledge must allow for communication and reflection with others. Therefore, reflection should be supported in various ways, for example, by carrying out guided small-group discussions during teaching-practice periods. *Reflection* refers to a process in which an experience is recalled, considered, and evaluated, usually in relation to a broader purpose (Zimmerman, 2002). Similarly, Rodgers (2002) describes reflection as a meaning-making process comparable to a research process and lists phases of reflection: setting aims and recognizing the problem(s), observing one's own behavior in practice, describing observations, and analyzing observations and experiences. The emphasis on reflection characterizes of the pedagogical studies of teacher education in both Finland and Korea (Jakku-Sihvonen & Niemi, 2006; Yun, 2002).

A professional teacher is often viewed as both a critical user and producer of educational knowledge (Gitlin et al., 1999; Pendry & Husbands, 2000; Reis-Jorge, 2005). A teacher is a user of educational knowledge when theory and practical experience are combined, or when educational situations are interpreted based on theoretical knowledge. The capacity to produce educational knowledge is needed when a teacher builds on knowledge that is based on her practical experience. Still, as Reis-Jorge (2005) notes, it is challenging for students to advance from consuming educational research to applying research knowledge and skills in school practice. In order to develop readiness to consume and produce educational knowledge, student teachers should be required, for example, to conduct their own small-scale educational research projects (Gore & Gitlin, 2004).

## THE FINNISH EDUCATIONAL CONTEXT

The teaching profession in Finland is highly appreciated, and it continues to appeal to and attract young people. This situation is explained by the fact that Finnish teachers are considered professionals who take responsibility for planning and evaluating activities, besides teaching in the classroom (Kansanen, Tirri, Meri, Krokfors, Husu, & Jyrhämä, 2000; Simola, 2005). In the Finnish education system, decision-making power is decentralized to the local level, and each municipality is responsible for planning the local curriculum, together with schoolteachers, in accordance with the National Core Curriculum (NCCBE, 2014) and for monitoring the quality of education. The “culture of trust” means that educational authorities and national-level educational policymakers believe in teachers and their knowledge of how to provide the best possible education for children and youth. For example, there have been no national or local school inspectors since the late 1980s, neither national-level assessments of basic education nor systematic evaluations of teachers (Sahlberg, 2011).

The Finnish education policy has aimed to promote educational equality that challenges teachers in a special way. All learners, despite their various backgrounds and abilities, are typically placed in heterogeneous classrooms; thus, teachers are called upon to support the learning of all students (Jakku-Sihvonen & Niemi, 2006; Laukkanen, 2008). Moreover, equality is promoted through a basic education system that is free of charge (i.e., schoolbooks and other learning materials, school meals, transportation, and health care are provided to everyone). Neither private schooling nor tutoring explains the good learning outcomes of Finnish pupils in general, whereas the private education sector has a great impact on learning outcomes in Korea (Kim, Lavonen, & Ogawa, 2009).

### Physics Teacher Education

Finnish secondary physics teachers of grades 7–12 hold a five-year master’s degree (300 cp<sup>1</sup>). Secondary teachers typically teach two subjects, such as physics and mathematics, in lower and upper secondary schools. Physics teacher education is organized in cooperation between the Faculty of Science and the Faculty of Education at the University of Helsinki. The program comprises studies in two main areas: subject matter-related courses taught in the subjects’ departments, and pedagogical courses (60 cp) overseen by the Department of Teacher Education. In the secondary teacher education program, students take a major (140 cp) and a minor (60 cp) in the subjects they intend to teach. They are expected to acquire a solid understanding of content knowledge of physics, especially the subject’s conceptual framework, on the basis of undergraduate courses at the subject department (Evagorou, Dillon, Viiri & Albe, 2015; Lavonen et al., 2007). Unlike the Korean system, in Finland, there is no special teacher examination to earn a teacher credential other than the university graduation diploma.

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<sup>1</sup>One credit point (cp) equals approximately 27 work hours, including lectures, small-group work, and self-directed learning.

The one-year pedagogical studies (60 cp<sup>2</sup>) foster a solid ground for functioning as a teacher. Courses can be classified into four categories: general education, educational research, subject pedagogy, and teaching practice (see [Table 1](#)). Students apply research methodology in their small-scale educational thesis. Moreover, different dimensions of the teaching profession, such as the social, philosophical, psychological, sociological, and historical bases of education, are discussed. The aim is not only to develop students' awareness of various themes, but also to reflect broadly on one's own personal conceptions of teaching and learning. The potential for lifelong professional development is considered essential (Lavonen et al., 2007; Lavonen & Krzywacki, 2011).

### THE KOREAN EDUCATION CONTEXT

The national-level school curriculum in Korea emphasizes quality of education and all citizens' equal opportunities for education (Ministry of Education, Science and Technology [MEST], 2009). The curriculum sets the basis for education in all school subjects. Regional guidelines allow some flexibility for schools and their teachers to customize their programs.

The teaching profession is popular in Korea as in Finland; only 5% of all applicants are accepted into the teacher education programs (OECD, 2004). However, despite the popularity of the teaching profession and the careful selection of eligible students, some concerns about the quality of teachers remain (Lee, 1995; Park, 2002; Yun, 2002). With this in mind, the Korean government has set three major goals for improving standards for the profession. First, teachers need to build the competence required to be autonomous experts. Second, school education should satisfy the public's demand for high quality. Third, a teacher's career should mean a stable and consistent position. In practice, the current movement in Korea is to increase teacher empowerment and upgrade their professional competence. After graduating from a university, pre-service teachers are required to pass a competitive examination administered by either a metropolitan or provincial office of education in order to obtain a teaching position (MEST, 2009).

In contrast to the Finnish system, the Korean teacher evaluation system has existed since 2010, aiming to improve teachers' professional competence. Teachers who receive poor evaluations are required to undergo additional training to address their particular needs (MEST, 2010). Teachers with high professional expertise can apply for leading positions at schools. Professional excellence can also be awarded with the nomination as a master teacher, one who acts as a peer mentor developing and disseminating effective teaching methods (MEST, 2009).

Basic and secondary education are free in Korea. However, the proportion of private expenditures on education in Korea is the highest among OECD member countries (OECD, 2005). Both students and their parents consider extra private education a vital part of the

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<sup>2</sup> One credit point (cp) equals 27 hour-long lessons comprising lectures and small-group work, apart from self-directed learning.

system (Kim & Kim, 2002). The effectiveness of a teacher and a school are assessed through the evaluation of students' learning outcomes (Bullough, Clark, & Patterson, 2003; Goe, Bell, & Little, 2008).

### Physics Teacher Education

Korean physics teachers are educated in four-year-long bachelor's degree programs (130–150 cp<sup>3</sup>), usually provided by a college of education. The degree includes studies in liberal arts (20%) and elective studies (20%), and the remaining 60% of coursework is focused on the student's major subject, including courses in subject-matter knowledge, the teaching of physics (in this case), general education, and teaching practice. The teacher education program at Seoul National University aims to educate competent and respected teachers who have a firm understanding of theoretical and experimental physics (Department of Physics Education at SNU, 2011). The pedagogical studies includes general studies (36 cp) and a set of special courses (21 cp), including pedagogical theory and teaching practice, as well as an educational thesis. The pedagogical portion of the program takes approximately one year to complete and is equal in length to the Finnish pedagogical studies (see [Table 1](#)).

### METHOD

This paper aims to analyze the pedagogical studies of Korean and Finnish physics teacher education programs by analyzing the programs' curriculum documents. Data analyses began with an inductive approach (Patton, 2002). The special focus makes it possible to juxtapose the programs, despite the fact that the organizations devoted to teacher education, including the credit points of the courses, differs. In practice, the aims set for the teacher education programs in both countries were examined and categorized, first, in terms of common themes emerging from the data. The expressions were categorized into ten themes characterizing the special emphasis of the programs. For example, there were aims focusing on the planning, implementation, and assessment of teaching; societal issues related to school and education; and the use of information and communication technology (ICT) in teaching and learning. However, the comparison of the outcome of the analysis is difficult because in Korean program there are several optional courses. Therefore, the comparison tell what topics two programs aims to introduce to students – not what an individual student might learn.

The second phase of the analysis involved a discussion of the program themes within the framework of teacher knowledge. All expressions were categorized in terms of both the domains and origin of teacher knowledge. Three subsets of teacher knowledge domains were used: 1) teaching and learning in general, which is associated with GPK, 2) teaching and learning a specific physics topic, which concerns PCK, and 3) educational research and research methodology (Res), which we added as a new domain of teacher knowledge that is

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<sup>3</sup> One credit point (cp) equals 16 hour-long lessons comprising lectures and small-group work, apart from self-directed learning. Therefore, in a one-credit-point course, a student participates one hour per week during and entire semester.

addressed in both Korean and Finnish teacher education programs. Each expression was also categorized in accordance with the idea of distinguishing between practitioner and professional knowledge regarding the origin of teacher knowledge (Hiebert et al., 2002).

Some issues emerged during the analysis, since not all expressions were clearly related to only one knowledge domain. For example, practical knowledge did not emerge only during teaching practice periods, but also along with the theoretical courses. Therefore, all expressions referring to knowledge construction through practical experience and reflection were associated with practitioner knowledge, in terms of the origin of teacher knowledge. Furthermore, we noticed that the theoretical approach also occurs during teaching practice, for example, when elaborating on the reasons behind pedagogical decisions in the classroom through conceptualization. We also made a clear distinction between the aims associated with GPK and PCK. For instance, the expression “Student teachers learn to design physics lessons by taking into consideration the research on teaching and learning” is considered PCK, since the emphasis is on the representation of content knowledge and understanding specific learning difficulties and student preconceptions (cf., Van Driel, Verloop, & de Vos, 1998).

In order to increase the validity and reliability (trustworthiness) of the analysis, three researchers analyzed the documents together. For example, the main categories emerging from the aims of Finnish and Korean physics teacher education (**Table 2**) were analyzed and discussed together, in order to yield an appropriate number of categories that still describe the original curricula documents. This discussion was challenging because the documents were written in the countries’ domestic languages, Finnish and Korean. The coding of all unites (typically sentences) in the curricula were also discussed together, in order to find agreement among the researchers.

## RESULTS

We discuss the teacher education programs in two phases in order to address the focus of the study (i.e., to examine how physics teacher education promotes the development of teacher knowledge). We start by describing the structure and themes of teacher education programs in order to clarify their core ideas. Then, the aims of the curricula are analyzed against the framework of three teacher knowledge domains (GPK, PCK, and Res) and the origin of teacher knowledge.

The pedagogical studies of physics teacher education programs in Finland and Korea include general theoretical parts, as well as teaching practice periods. The Finnish teacher education program comprises six separate courses and three teaching practice periods, whereas the Korean program consists of 17 separate courses and two teaching practice periods (see **Table 1**). The amount of time spent focused on pedagogical studies is relatively the same in both countries, about one year. The meaning of the credit points varies between Finland and Korea. In Finland, one credit point (cp) is equal to 27 hours of work, including about 1/3 time of lectures and workshops and 2/3 self-directed learning. In Korea, one credit point is equal

to 16hour-long lessons, comprising lectures and small-group work, and apart from self-directed learning. One Finnish cp is about 2/3 of a Korean cp.

**Table 1.** Structure of Teacher Education Programs in Finland and Korea

	<b>University of Helsinki (Finland)</b>	<b>Seoul National University (Korea)</b>
General courses on education, teaching and learning (GPK)	Psychology of development and learning, 4 cp (Psy) Special needs education, 4 cp (Spe) Societal, historical and philosophical foundations of education, 5 cp (Phil)  <b>Total 13 cp</b>	<i>Compulsory (4 cp)</i> Understanding special education and special needs students, 2 cp (Spe) Understanding the nature of teaching profession, 2 cp (Work)  <i>Optional (14 cp)</i> Introduction to education, 2 cp (Intro) Educational psychology, 2 cp (Psy) Philosophy and history of education, 2 cp (Phil) Educational sociology, 2 cp (Socio) Curriculum, 2 cp (Cur) Educational evaluation, 2 cp (Eval) Administration and management in education, 2 cp (Admi) Educational methodology and technology in education, 2 cp (Tech) Guidance and counseling, 2 cp (Guid) <b>Total 18 cp</b>
Pedagogy of physics (PCK)	Introduction to physics teaching, 10 cp (Cur) Evaluation and development of teaching, 7 cp (Eval)  <b>Total 17 cp</b>	<i>Optional (8 cp)</i> Physics education, 3 cp (Phy_edu) Textbooks and teaching in physics education, 3 cp (Book) Teaching practice and analysis of secondary school physics education, 3 cp (Prac_anal) History of physics concepts, 3 cp (Phy_con) Logic and essay in physics, 3 cp (Phy_loc) <b>Total 8 cp</b>
Educational research	Teacher as a researcher seminar, 10 cp (Sem) that comprises: <ul style="list-style-type: none"> <li>• research methodology in education (3 cp)</li> <li>• teacher as a researcher seminar(3 cp)</li> <li>• minor thesis in pedagogy (4 cp)</li> </ul> <b>Total 10 cp</b>	Research on physics education (0 cp) (Phy_res)  <b>Total 0 cp (accepted without credits)</b>
Teaching practice	Basic teaching practice in Teacher Training School, 7 cp (B_prac) Applied practice, 5 cp (Ap_prac) Master's level practice in Teacher Training School, 8 cp (Ad_prac)  Reflection, supported by portfolio assessment work as part of teaching practice (Ref) <b>Total 20 cp</b>	Teaching practice, 2 cp (Prac) Voluntary activity in education, 2 cp (Vol_prac)  <b>Total 4 cp</b>
Grand total	60 cp	30 cp
	1 credit point (cp) = ~27-hours of work, including lectures, small-group work, and self-directed learning	1 credit point (cp) = 16 hours lesson, including lectures and small-group work, apart from self-directed learning

Note: Course acronyms are indicated in parentheses.

The organization of the pedagogical courses also differs; for example, due to the big number of separate courses. In Korea, individual courses comprise less content and shorter length than those in Finland. Furthermore, Korean courses are named meticulously in relation to their content. In contrast, there are typically several aims set for individual Finnish teacher education courses. For example, the course “Introduction to Physics Teaching” covers several topics, such as teaching and learning physics, student interest and motivation in physics, national and local curricula including curriculum planning, teaching and assessment methods, and the use of ICT in physics education. Optional studies are included in the Korean teacher education program, whereas the courses in Finland are all compulsory for everyone.

Further elaboration on the aims of the teacher educational programs reveals a multifold picture of the core idea of teacher education in both countries. In the following sections, we discuss the main themes emerging from the aims set for individual courses. It is noteworthy that the course list includes overlapping themes and approaches; thus, some themes are addressed in several parts of the program. Six categories of the aims are addressed in both Finnish and Korean teacher education curricula, and several common themes emerge (see **Table 2**). The numerical and percentage distributions of the aims across the main themes are shown in order to juxtapose the pedagogical parts of the teacher education programs. For example, the role of education in society is considered an important theme, especially in Korea (27%), and to a lesser extent in Finland (19%). Consequently, student teachers become aware of the different dimensions of the teaching profession in their own country through both theoretical coursework and practice.

One of the common categories is reflection, which is perceived as an essential part of the teaching profession (Finland 17%, Korea 18%). As defined by Zimmerman (2002), reflection refers to an activity in which an experience is recalled, considered, and evaluated in order to learn as a professional. The aims concerning reflection and reflective activities are distributed over several courses and teaching practice periods in both the Finnish and Korean teacher education programs.

**Table 2.** Main Categories Emerging from the Aims of Finnish and Korean Physics Teacher Education, Definitions of the Categories, and Examples of Original Expressions

Main Category	Definition	Examples of Original Expressions	
Planning instruction, teaching, and assessment	Student teachers learn to design a local curriculum, plan lessons, teach, and support students' learning of knowledge, skills, and attitudes. In addition, they learn to use versatile methods of teaching and assessment. Both the national core curriculum and research-based knowledge about learning and development should be considered at all phases of the process.	Fin (24%)	Student teachers <ul style="list-style-type: none"> <li>- develop readiness to understand different views of learning. (Psy)</li> <li>- become familiar with issues of group development. (Psy)</li> <li>- learn interaction skills. (Psy)</li> <li>- learn to design physics teaching by considering research knowledge on teaching and learning. (Cur)</li> <li>- learn how to evaluate student learning. (Eval)</li> </ul>
		Kor (34%)	Student teachers <ul style="list-style-type: none"> <li>- learn to apply basics of educational psychology to instruction. (Psy)</li> <li>- are able to select the appropriate textbooks, contents, and methods. (Book)</li> <li>- learn the fundamentals of theory and practice of the physics educational curriculum. (Cur)</li> <li>- learn techniques to guide and provide counseling. (Guid)</li> <li>- learn methods for applying educational evaluations in school. (Eval)</li> </ul>
Role of education in society	Student teachers gain educational knowledge about different perspectives on the role of education in society, such as the school institute as part of society and the curriculum as an education policy document.	Fin (19%)	Student teachers learn to <ul style="list-style-type: none"> <li>- analyze the historical and societal basis of the school system. (Phil)</li> <li>- cooperate with various interest groups collaborating with the school, such as parents. (Eval)</li> <li>- contribute to the development of the local-level curriculum. (Eval)</li> <li>- discuss critical collaboration with different interest groups. (Ad_prac)</li> </ul>
		Kor (27%)	Student teachers <ul style="list-style-type: none"> <li>- learn about the characteristics and relevance of different fields of educational knowledge. (Intro)</li> <li>- understand the relevance of education to society. (Socio)</li> <li>- learn about the conceptualization of three educational perspectives. (Intro)</li> </ul>
Educational research	Student teachers learn how to apply research-based knowledge in their teaching and how to carry out a small-scale educational research program.	Fin (16%)	Student teachers learn <ul style="list-style-type: none"> <li>- to apply research-based knowledge in physics teaching.</li> <li>- how to utilize research methodology. (Sem)</li> </ul>
		Kor (7%)	Student teachers <ul style="list-style-type: none"> <li>- learn to frame a research theme related to physics education.</li> <li>- produce a thesis, including both the empirical sections and a research literature review under the guidance of academic advisors. (Phy_res)</li> </ul>
Use of information and communication technologies (ICT) in teaching and learning	Student teachers learn how to use ICT in teaching and learning.	Fin (4%)	Student teachers develop their readiness to employ ICT in the teaching and learning of physics. (B_prac)
		Kor (2%)	Student teachers learn how to apply methods, techniques, and theories of educational technology in schoolwork. (Tech)
Reflection	Student teachers learn to reflect. Reflection refers to an activity in which an experience is recalled, considered, and evaluated.	Fin (17%)	Student teachers learn to analyze their personal development as teachers. (Cur)
		Kor (18%)	Student teachers learn to reflect on the strengths and weaknesses of each theory on teaching practice. (Socio)
School practice	Student teachers gain some teaching experience and understand that multiprofessional collaboration is part of school work.	Fin (7%)	Student teachers learn how to work in multiprofessional collaboration at schools and to assume professional responsibility. (Ad_prac)
		Kor (6%)	Student teachers play an active role as educational volunteers and acquire teaching experience. (Vol_prac)

It is also noteworthy to pay attention to special themes that emerge in only one of the teacher education programs. Special themes cover 14% of Finnish and 9% of Korean programs. Discussing the different needs of students and considering how to support various learners comprise a special theme in Finnish teacher education, which aims to emphasize the importance of providing equal learning opportunities to various kinds of learners. Moreover, the nature of science, especially concerning physics as a school subject, is also discussed as a topic in the course “Introduction to physics teaching” in Finland (see [Table 3](#)).

**Table 3.** Special Themes Addressed Only in Finnish Physics Teacher Education

Main Category	Definition	Examples of Original Expressions
Different needs of students (11%)	Student teachers learn to consider the different needs of students and to identify students' learning difficulties.	Student teachers learn to - identify different kinds of learners. (B_prac) - identify pupils' learning difficulties. (Spe)
The nature of the subject (physics) (3%)	Student teachers learn to design physics lessons and take into account the nature of science.	Student teachers learn to design subject (physics) lessons by considering the epistemological and ontological assumptions of the subject. (Eval)

On the other hand, the pedagogical courses in the Korean teacher education program address issues related to educational reality and school context, as well as a teacher's attitude (see [Table 4](#)). Interestingly, the latter category concerns the view of an ideal (physics) teacher and his commitment to the teaching profession.

**Table 4.** Special Themes Addressed only in Korean Teacher Education

Main Category	Definition	Examples of Original Expressions
Educational reality (4%)	Student teachers learn about educational practice, reality, and school context. They also learn how to solve problems at school.	Student teachers understand the characteristics of physics education and discuss practices from an educational perspective. (Intro)
Teacher's attitude (5%)	Student teachers learn about an ideal teacher's attitude, role and duties, as well as mission and professionalism.	Student teachers learn about the profound attitude of an ideal teacher. (Prac)

The Finnish and Korean teacher education programs are shown in a somewhat different light in terms of the domains and origin of teacher knowledge. As illustrated in [Table 5](#), the emphasis on different domains of teacher knowledge varies. Generally, the aims of the Finnish program are more equally distributed among the three domains of teacher knowledge than those of its Korean counterpart. The Finnish teacher education curriculum is grounded on the balanced structure of GPK, PCK, and research knowledge. In contrast, Korean teacher education seems to be grounded more strongly on GPK (71%) than is the case in Finland (49%),

which confirms the results published by Kim, Ham, and Paine (2011), Park (2000), and Yun (2002). In essence, the main themes of GPK are the same in both programs, except that the needs of different kinds of learners form a special theme discussed only in Finnish physics teacher education.

Both Finnish and Korean teacher education programs place approximately the same emphasis on PCK. According to our analysis, issues related to planning instruction, teaching and assessment, and aims regarding reflection, are discussed not only at a general level, but also in the context of physics education. In the Finnish program, other themes, such as the use of ICT in teaching and learning physics and the different needs of students, are also discussed from the special perspective of teaching and learning physics.

Interestingly, the emphasis on educational research and carrying out a research project is greater in the Finnish (16%) teacher education program than in the Korean (4%) one. However, the research category provides information only about activities that aim either to produce research or to learn about the research process itself. Many expressions of using and applying research knowledge were associated with other domains of teacher knowledge, such as PCK.

**Table 5.** Numerical and Percentage Distributions of the Aims across the Main Categories in Finnish and Korean Teacher Education

Main category	Numerical and percentage distributions of the aims							
	Finland				South Korea			
	GPK	PCK	Res	Total	GPK	PCK	Res	Total
1. Planning instruction, teaching and assessment	7	11		18 24%	11	10		21 34%
2. Role of education in society	14			14 19%	17			17 27%
3. Educational research			12	12 16%			4	4 7%
4. Use of ICT in teaching and learning		3		3 4%	1			1 2%
5. Reflection	7	6		13 17%	7	4		11 18%
6. School practice	5			5 7%	4			4 6%
7. Different needs of students	4	4		8 11%				0
8. The nature of the subject (physics)		2		2 3%				0
9. Educational reality				0	2			2 4%
10. Teacher's attitude				0	3			3 5%
	37	26	12	75	45	14	4	63
	49%	35%	16%	100%	71%	22%	6%	100%

Finally, we discuss the Finnish and Korean teacher education programs by comparing the distribution of teacher knowledge domains against the categorization of knowledge origin (see Table 6). In Finland, 53% of the aims are associated with professional knowledge and 47% with practitioner knowledge. The corresponding results concerning Korean teacher education comprise 73% and 27%, respectively. The Finnish system seems to be rather balanced in terms

of the origin of teacher knowledge, while a professional approach to teacher knowledge dominates the Korean teacher education program. The findings are partly a consequence of the roles of teaching practice and research orientation in the programs. Teaching practice constitutes 20 credit points of Finnish teacher education, which forms one-third of the pedagogical studies (60 cp) (Jakku-Sihvonen & Niemi, 2006; Pehkonen, Ahtee, & Lavonen, 2007). In the Korean program, only four credit points are allocated for teaching practice, which is equal to one-seventh of the program (30 cp).

**Table 6.** Comparison of Numerical and Percentage Distributions of Teacher Knowledge Domains against the Origins of Teachers' Knowledge

Origin of Teacher Knowledge	GPK		PCK		Res		Together		
	Count	Percentage	Count	Percentage	Count	Percentage	Count	Percentage	
Practitioner	Finland	22	29%	8	11%	5	7%	35	47%
	Korea	7	11%	6	10%	4	6%	17	27%
Theoretical	Finland	15	20%	18	24%	7	9%	40	53%
	Korea	38	60%	8	13%	0	0%	46	73%
Total	Finland	37	49%	26	35%	12	16%	75	
	Korea	45	71%	14	22%	4	6%	63	

Finnish physics teachers' pedagogical studies include a relatively small amount of aims concerning the practitioner's approach to PCK. Instead, PCK is approached rather theoretically, whereas the practitioner approach is likely associated with general themes of education. The Korean approach to PCK is more balanced concerning practitioner and theoretical approaches, although no special stress is laid on PCK in the program. Both Korean and Finnish student teachers are expected to be involved with the research process in accordance with the aims of their programs, such as using educational research and engaging with research activities as part of teacher education (cf., Pendry & Husbands, 2000). The core of the pedagogical studies in Korea is founded on general pedagogical themes that are approached theoretically (60%). Research knowledge is included in both Finnish and Korean teacher education, but only the Finnish program provides a theoretical approach to research themes.

## CONCLUSIONS AND DISCUSSION

We have examined and compared the pedagogical studies in Finnish and Korean physics teacher education programs by analyzing what kind of knowledge construction they aim to support. Notably, it is impossible to examine the actual amount of lesson hours allocated to particular themes by analyzing and categorizing the aims of the pedagogical studies. Instead, the classification lets us discuss the importance of each category that reflects a particular subset of aims and provides a fruitful ground for elaborating on special features, as well as the organization of initial teacher education. The analysis helps us understand what aims the programs emphasize. We have focused on the pedagogical studies in teacher

education that aim directly to improve pre-service teachers' professional abilities (Kim et al., 2011; Shulman, 1986).

The organization of pedagogical studies as part of the physics teacher education program varies to some extent between Korea and Finland. Both Finnish and Korean teacher education seem to place the same emphasis on pedagogical studies in relation to the overall program. However, it is also noteworthy that the Korean program is carried out at the four-year bachelor's degree level, whereas Finnish physics teachers acquire their qualifications for the teaching profession during a five-year master's level program. However, the amount of time spent on pedagogical studies in the program is almost the same, even though the calculation of credit points differs. Finnish teachers are claimed to have a profound starting point as professionals due to the emphasis on initial teacher education. Even Finnish students' success in the PISA testing is perceived as a consequence of the high quality of their schoolteachers (Hautamäki et al., 2008; Sahlberg, 2008). However, the role of Korean teachers in Korean students' success has not been emphasized as much. An explanation is that Korea currently has the world's largest system of supplementary private "cram schools" and tutors (Baker & LeTendre, 2005; Kim, Lavonen, & Ogawa, 2009), which hardly exist in the Finnish education system.

In general, pedagogical studies of physics teacher education programs can be organized as fostering primarily either higher competence levels in particular themes or by their general stance towards the teaching profession (Darling-Hammond & Bransford, 2005; Grossman, 1990; Hargreaves, 1994; Levin, 2008). Teacher educators who emphasize the role of teachers as deliverers of information tend to support developing a thorough knowledge base, while those who stress the reflective and investigative role are likely to rely on a reflective and research-based approach, with less emphasis on particular contents (Hargreaves, 1994; Levin, 2008). In practice, the question of depth versus breadth involves the degree of specialization and the integration of courses (Darling-Hammond & Bransford, 2005; Grossman, 1990). The distribution of and emphasis on courses differ greatly between Korean and Finnish teacher education. The number of courses is greater in Korea than in Finland, where the amount of separate courses has been reduced based on student feedback (Lavonen & Krzywacki, 2008). It seems that, in Finland, this reduction has led to a need to consider carefully the core ideas and compose a coherent whole in general, while Korean teacher education aims to cover a broader range of topics. The Korean program comprises several individual courses. For example, the themes concerning educational sociology, philosophy, and history are discussed in separate courses in Korea, whereas the Finnish program addresses the same themes in a single integrated course.

The emphasis placed on different teacher knowledge domains reflects the national education cultures of both countries, and the basis of both Korean and Finnish teacher education programs has been developed over several decades (Jakku-Sihvonen & Niemi, 2006; Kang, 1995). A comparison of the programs reveals distinct approaches to the different domains of teacher knowledge. Pedagogical studies in Korean teacher education clearly

prioritize GPK, while the Finnish program is based on a rather balanced distribution among the three domains of teacher knowledge. Furthermore, some themes reveal the special emphasis of the Finnish education system, such as focusing on how to address the various needs of students. The theme of differentiation and special needs education is included in the Finnish program as a result of the national education policy that stresses equality.

It is also possible to characterize teacher education programs by elaborating on missing themes. For example, Korean teacher education lacks the theme of special needs education, which is not highlighted in the national education policy. Moreover, neither Korean nor Finnish teacher education programs have set special goals related to collaboration with parents and various societal interests. However, these issues are dealt with slightly during teaching practice periods. Only a small number of goals are related to the use of ICT in teaching and learning. It is noteworthy that the European Commission (2010) emphasizes the significance of both school partnerships and collaboration and the utilization of technological applications in schools.

Most of the differences are consequences of the historical development of teacher education in both countries (Kang, 1995; Kansanen, 1993; Kwak, 1998). The pedagogical studies as a part of the Finnish teacher education program have focused on PCK, on “didactics” to be precise, since the master-level teacher education qualification was established at the end of the 1970s (Jakku-Sihvonen & Niemi, 2006; Simola, 1998). From the beginning, the balance between PCK and GPK has been attained in Finnish teacher education. Furthermore, the research orientation has been regarded as a guiding principle of the Finnish program, where student teachers learn about and through research (Jakku-Sihvonen & Niemi, 2006; Lavonen & Krzywacki, 2008; Teacher Education Development Program, 2001). The research orientation is realized over several courses and during the teaching practice period by using and producing educational research (cf., Korthagen, Loughran, & Russel, 2006). Activities aim not only to produce and understand research, but also to build readiness for lifelong learning and taking a critical stance towards teaching. Second, through an emphasis on research, teachers are educated on how to research or reflect on their own practice and improve it (Evagorou et al., 2015). Consequently, the emphasis on research orientation helps strike a balance between the aims focusing on professional and practitioner knowledge. Student teachers become familiar with research through various activities that are founded on recent educational research. All three teacher knowledge domains have been emphasized equally in Finnish teacher education, with no radical changes over the years.

The Korean education policy on teacher education has been different due to its continuous process of change. However, its development has not concerned the balance among different teacher knowledge domains (Kang, 1995; Kwak, 1998; Park, 2000). Since the 1970s, Korean teacher education has aimed primarily at developing GPK, which is regarded as essential for the profession (Kang, 1995; Kim, 2005; Yun, 2002). However, research knowledge and skills have not been considered a crucial part of bachelor-level teacher

education (Park, 2000; SNUCE, 2009). Student teachers are required to complete a minor thesis, but research knowledge plays a rather insignificant role in the program.

The pedagogical studies of physics teacher education programs appear quite different if approached in terms of the origin of teacher knowledge (Hiebert et al., 2002). Several scholars have stressed the importance of finding a balance between professional (theoretical) and practitioner knowledge (see e.g., Grossman, 1990; Hargreaves, 1994; Richardson, 1997). University-level education has traditionally aimed at helping students to gain professional knowledge, for example, through the reading different texts, articles, and research literature. On the other hand, practitioner knowledge is acquired through student teachers' practical experience during teaching practice periods only (Darling-Hammond & Bransford, 2005; Levin, 2008). Pedagogical studies in both Korea and Finland include a limited amount of this kind of practical experience. Since practitioner knowledge is unlikely absorbed straightforwardly from practical experience, reflective activities play an essential role in both Korean and Finnish teacher education.

Reflective activities require students to assume an active role by setting personal goals apart from the official general aims for teaching practice. Student teachers are encouraged to note observations of their own activities, both inside and outside the classroom, and, finally, to reflect on these notions against the original aims (cf., Rodgers, 2002). Supervision helps to approach practical experience from different perspectives, and their degree of independence increases along with their progress. The emphasis on professional or practitioner knowledge in a teacher education program is a consequence of the philosophical stance towards learning in general (Hargreaves, 1994; Richardson, 1997). The Finnish teacher education program emphasizes subjectivity in building knowledge and skills, so that student teachers are expected to integrate subject-matter knowledge, PCK, and GPK into their own personal pedagogical theories (Jakku-Sihvonen & Niemi, 2006; Pehkonen et al., 2007). In contrast, the Korean teacher education program is based on the idea of teachers as deliverers of knowledge (Kang, 1995; Kim, 2005; Park, 2000; Yun, 2002). Consequently, the Korean program seems to stress a solid ground for a broad range of knowledge and skills that teachers should acquire (Lee, 1995). This knowledge is also tested with a written examination when a teacher applies for a position at a public or private school. The result is the emphasis on professional knowledge in the Korean program.

The outcome of the content analysis of Finnish and Korean pedagogical studies of physics teacher education programs could be easily reflected in terms of an ideal professional or an effective teacher. In both countries, teachers hold high status; therefore, teacher professionalism is recognized (Müller, Norrie, Hernández, & Goodson, 2010). Nonetheless, in Korea, an ideal teacher is regarded as effective, rather than professional, due to the emphasis on the comparison of student learning outcomes and ranking to evaluate teachers (Williamson & Walberg, 2004). The Korean education system is close to the accountability approach, where testing is organized in order to identify effective and ineffective schools and teachers.

To conclude, the domains and origins of teacher knowledge make it possible to elaborate on the structure and organization of the pedagogical studies of physics teacher education programs and thus to juxtapose two different teacher education programs representing distinct traditions. The domains of teacher knowledge and the emphasis of separate domains provide a perspective on teacher education, but a deeper examination is possible only by explaining teacher education through the origin of knowledge. The programs educate teachers based on different education contexts, which is advisable to keep in mind when drawing conclusions from the analyses. Actually, the analyses of the programs reflect, to a large extent, the countries' educational contexts. As Lederman and Lederman (2015) argue, because of the differences in context, we must conclude that there is no single best way to educate future physics teachers.

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