

Physics Teacher Education Programme in Finland: Teacher knowledge as an analytical approach

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ABSTRACT

The Finnish lower and upper secondary school physics teacher education programme is presented and analysed through the lens of a theoretical framework based on two facets related to teacher knowledge: the structure and forms of teacher knowledge. The structural perspective is based on different domains of teacher knowledge, such as subject matter knowledge, pedagogical content knowledge and general pedagogical knowledge. Practical and professional knowledge are at the ends of the continuum describing forms of teacher knowledge, i.e. the dilemma of “way of knowing”. Students’ evaluation data of the programme, national strategies and research on teaching and learning are described as influential factors in designing, implementing, and developing the programme. Moreover, some information about educational context and the role of teachers in schools is given. From an epistemological viewpoint, research-based teacher education provides both contents and activities that support formation of different knowledge fields needed for acting as a teacher. In addition, the nature of teacher knowledge, the distinction between practical and professional knowledge, is looked at during the studies. However, it is a challenge for academic teacher education to address students’ epistemological viewpoints and to support individual development processes regarding teacher knowledge.

Introduction

The aim of the article is to analyse and discuss Finnish teacher education for teachers at the secondary and upper secondary school level. We have selected the pre-service teacher education programme for physics teachers at the University of Helsinki as an example. The theoretical framework through which the programme is analysed is based on teacher knowledge. It consists of two facets related to teacher knowledge: the structure and forms of teacher knowledge. The former viewpoint, the structural perspective, is based on different domains of teacher knowledge, such as subject matter knowledge, pedagogical content knowledge and general pedagogical knowledge, and the distinctions between these separate domains (Carlsen, 1999; Hashweh, 2005; see also Shulman 1987). The latter viewpoint, forms of teacher knowledge, is connected to the dilemma of “way of knowing”. Here, we use the concepts of practical and professional knowledge as the ends of the continuum describing teacher knowledge. These two concepts are distinguished, for example, through origin of knowledge and through certain requirements, such as to what extent knowledge is sharable with others or is accumulative (Hiebert, Gallimore & Stigler, 2002, see also Korthagen, 2007).

As background information, the overall framework for designing and implementing the teacher education programme at the University of Helsinki is presented in Figure 1. This allows us to understand better the Finnish educational context in general. Influential factors, such as the role of students’ evaluation data of the programme and national strategies for the development of the programme are discussed. We start the analysis of the teacher education programme with the domain of content knowledge that students should learn during their physics studies at the Department of Physics. Following this, pedagogical studies as a part of the teacher education programme are analysed. In the pedagogical studies, especially during teaching practice periods, students integrate different knowledge domains, such as subject matter knowledge, pedagogical content knowledge, and general pedagogical knowledge with practical knowledge through teaching experiences. Therefore, pedagogical studies can be considered as a meeting point for separate domains of teacher knowledge.

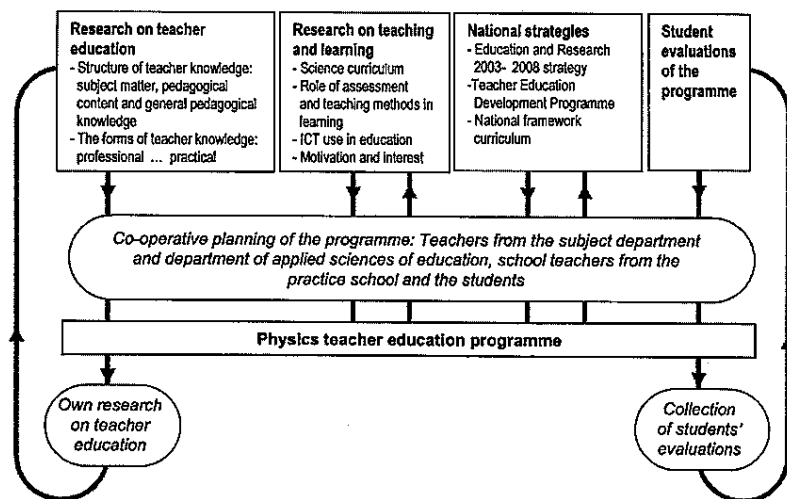


Figure 1. Framework for designing and implementing the teacher education programme at the University of Helsinki.

Theoretical framework of teacher knowledge

The framework for this article on subject teacher education is based on two theoretical perspectives of the epistemology of teacher professional knowledge: 1) The structural view of teacher professional knowledge with separate knowledge domains, and 2) the faces of professional knowledge.

Domains of teacher knowledge

Discussion on teacher knowledge, regarding different models and the meaning of knowledge domains for the teaching profession, like pedagogical content knowledge, has been at the focus of research for a number of years (e.g. Carlsen, 1999; Grossman, 1990; Hashweh, 2005; Shulman 1986 & 1987). Like Carlsen (1999) states, models of teacher knowledge vary according to knowledge categories distinguished from each other. The starting point for the concept of teacher knowledge is in Shulman's work (1986, 1987) in which the distinction between content knowledge, pedagogical content knowledge

and curricular knowledge in general was made. Further development of the model has taken place. For example, Carlsen (1999) has further developed the model, dividing teacher knowledge into five categories in his study on pedagogical content knowledge: (1) knowledge on general educational context, (2) knowledge about special educational context, (3) general pedagogical knowledge, (4) subject matter knowledge, and (5) pedagogical content knowledge (PCK). The characterising feature for the structural model of teacher knowledge is that separate knowledge domains are distinct from each other and defined by relationships with each other. However, missing the idiosyncratic feature of teacher knowledge as well as the historical and political context, are considered a disadvantage for such models. Cognitions of teachers, such as the ability to make pedagogical decisions and individuality, are not addressed in structural models (Carlsen, 1999; cf. Hashweh, 2005). However, the structural model is of use for designing study programmes or for clarifying the knowledge base for the teaching profession.

Pedagogical content knowledge (PCK) is a special knowledge domain for teachers distinguishing them from other subject specialists (Shulman, 1987; Carlsen, 1999). In physics and chemistry teacher education, PCK has been used as a framework to help student teachers to analyse and describe instruction. Various scholars have further developed conceptualisations of PCK as an academic construct representing science teachers' knowledge of practice (e.g., Van Driel, Verloop & de Vos, 1998; Magnusson, Krajcik & Borko, 1999; Appleton, 2002; Loughran, Mulhall & Berry, 2004). As such, PCK has become a way of understanding the complex relationship between physics and chemistry teaching and content through the use of specific teaching methods, and is developed through an integrated process rooted in classroom practice (Van Driel et al., 1998). The aim has been to find implications for the PCK both in research and in practice (Gess-Newsome & Lederman, 1999). For example, Hashweh (2005, 277) has defined PCK as "the set or repertoire of private and personal content-specific general event-based as well as story-based pedagogical constructions that the experienced teacher has developed as result of repeated planning and teaching of, and reflection on the teaching of, the most regularly taught topics".

When focusing on the teacher education for secondary school physics teachers, domains of subject matter knowledge and pedagogical content knowledge are of special interest. The central role of subject matter knowledge, here expertise in physics as a discipline, can be seen to be essential for a physics teacher. According to Gess-Newsome (1999), research on knowledge and beliefs about subject matter of secondary teachers and its impact on the teaching process have been of wide interest. She concludes that attention should be paid to methods of teaching through which the attitudes and knowledge of teachers could be influenced. In addition, teachers need to understand the nature of their discipline.

The third main category of teacher knowledge is general pedagogical knowledge. In Finland, the following areas are traditionally included as part of general pedagogical knowledge: learning theories, motivation and interest, assessment, special education, history and philosophy of education, national level planning of education and the role of curriculum in education and research methods in education. According to Gore and Gitlin (2004), teachers dismiss pedagogical knowledge based on academic research on the grounds that it is not practical, contextual, credible, and accessible enough. In order to face the problem of combining theory with practice, student teachers have been required for example to carry out their own small-scale educational research (Gore & Gitlin, 2004). In addition, the role of experience seems to be a central factor when discussing teachers' stances toward educational knowledge and its verification (Joram, 2007). Especially the origin and nature of knowledge is an issue when thinking about the meaning of practical experience as a source for pedagogical knowledge (see also Kosunen & Mikkola, 2002).

Distinction between professional and practical knowledge

Furthermore, in addition to different knowledge domains, epistemological features of knowledge are of interest (Hiebert et al., 2002) while planning a teacher education programme. Distinction between knowledge constructed in practice and knowledge based on educational research is another focal point of this article. Basic academic competences, such as research skills, are not emphasised in the original knowledge categories introduced by Shulman

(1986, 1987). However, in Finnish teacher education programmes at least the viewpoint of the consumer of educational research is emphasised (Kansanen, Tirri, Meri, Krokfors, Husu & Jyrhämä, 2000; Lavonen et al., 2007). This kind of movement can also be recognised in research on teacher education in general (e.g., Korthagen, Loughran & Russel, 2006).

Hiebert, Gallimore and Stigler (2002) divide teacher knowledge into two categories: *practitioner* knowledge and *professional* knowledge. In the field of education, it is assumed that professional knowledge is best built upon researchers' knowledge due to its generalisable and scientific character. Posing research knowledge in such a form that teachers would adapt its ideas is a challenge due to the difficulties of translating research knowledge into teacher's reality, into school practice. According to Hiebert et al. (2002), practitioner knowledge has three essential features for a teacher. Firstly, practitioner knowledge is linked with practice, as it develops in response to practical problems in the classroom. Hence, it is grounded in the real life context and addresses specific problems of processes that really exist in the classroom. Secondly, practitioner knowledge is specific, detailed, and concrete. Thirdly, practitioner knowledge is integrated, meaning that it is linked with practice and organised by particularities of practice.

In order for practitioner knowledge to become professional knowledge, some additional requirements have to be addressed. These features relate to making knowledge public and commonly shared. Hiebert et al. (2002) emphasise that professional knowledge has to be public, and in order to fulfil such a requirement, it has to be represented in such a way that it can be communicated with others. Consequently, collaboration becomes essential as it forces participants to make their knowledge public and understood by others. Korthagen (2007) argues that teachers have difficulties in conceptualising their knowledge. Besides being public, knowledge has to be sharable and accumulative. As a last requirement, Hiebert et al. (2002) state, that professional knowledge has to be accurate, verifiable, and continually improved.

The question concerns not only what is seen as valuable knowledge and skills, but also how student teachers are able to learn new things. Pre-service teachers tend to use their personal experiences as critical filters in adopting and integrating new contents in teacher education courses. In order to take

student teachers' starting points into consideration, Trotman and Kerr (2001) suggest that integration of personal history with professional learning is of help. Student teachers should be able to reflect upon their own preconceptions of pedagogical knowledge and should understand the meanings of key concepts used in designing, organising and evaluating learning and instruction and, moreover, understand the value of pedagogical courses (Haritos, 2004; Younger et al., 2004). The contents included in the studies can be made more meaningful for an individual student from the point of view of the teacher profession. Trotman and Kerr (2001) state, that through integrative activities two stages can be addressed. Firstly, student teachers become conscious of their values and beliefs that have been internalised as a consequence of former activities and experiences. Secondly, besides becoming aware of their own starting points, students should be given opportunities to reflect critically on and expand the understanding and insight they derive from making the internal more external and explicitly understood.

Influential factors in designing physics teacher education in Finland

The teacher education programme can be seen as a result of a design process in which several influential factors have been taken into consideration (see Figure 1). Firstly, there is an emphasis in the programme on both professional and practitioner knowledge. A characterising theme in Finnish teacher education is a research-based approach. Educational research and research methodology has influenced the structure and implementation of the programme. For example, master's level educational research and reflective activities related to teaching practice periods are seen as tasks through which a student takes an active role and strengthens their abilities for reflective thinking. The main characterising theme of Finnish teacher education includes also the idea of practitioner knowledge and learning through practice. A Finnish teacher should be a pedagogically thinking, reflective practitioner, who is an expert in their subject matter and educational issues regarding teaching and learning (Kansanen et al., 2000; Lavonen, Krzywacki-Vainio, Aksela, Krokfors, Oikkonen & Saarikko, 2007).

Secondly, students construct their base of professional knowledge during the studies provided by different university departments and during the teaching practice in university teaching practice schools. Therefore, co-planning and coordination within the study programme are needed to ensure that different domains of teacher knowledge, such as subject matter knowledge, pedagogical content knowledge and general pedagogical knowledge as well as distinctions between these separate domains are provided in a balanced way during the studies. Consequently, co-operation between university partners responsible for different parts of teacher education programmes and student teachers, has been considered to be of importance in the planning and development process in Finland. Typically, partners in Helsinki discuss and develop the teacher education programme collaboratively two or three times a year. The collaborative work does not only concern practical issues regarding the implementation of the teacher education programme, but also involves general level visions of teacher education. For example, the parties involved in the physics teacher education have agreed together on a common vision for the whole teacher education programme, including description of knowledge and skills in the subject matter and pedagogy, as well as of competence for continuous professional development (see more Lavonen et al., 2007).

Thirdly, national level strategies for Finnish teacher education have been taken into consideration when planning the teacher education programme and its implementation. Education policy documents are prepared in Finland by the Finnish Ministry of Education (ME). According to the general national education strategy *Education and Research 2003-2008* (ME, 2004) and several previous ones, education at the university shall be based on scientific research and professional practices in the field. The teacher education programme should especially provide the students with the knowledge and skills needed for operating independently as an expert and developer in the field. In addition to the general strategy, there are also other strategies describing goals for teacher education, such as the *Teacher Education Development Programme* (ME, 2002). According to this, the teacher education programmes should help students among other things to acquire:

- high-level subject knowledge and pedagogical content knowledge, and knowledge about how knowledge is constructed,
- academic skills, such as research skills; skills to use pedagogically Information and Communication Technology; skills needed in developing a curricula,
- social skills, such as communication skills; skills to cooperate with other teachers,
- knowledge about school as an institute and its connections to society (school community and partners, local contexts and stakeholders),
- moral knowledge and skills, such as social and moral code of the teaching profession,
- skills needed in developing one's own teaching and the teaching profession.

Finnish National Board of Education (FNBE) takes care of the implementation of the education policy at school level through the *National Core Curriculum for Basic Education* (FNBE, 2004). Consequently, fourthly, the framework curriculum of comprehensive school including the main aims for teaching and learning physics as a school subject have been taken into consideration when planning the teacher education programme and its implementation. In the general part of the National Core Curriculum for Basic Education (FNBE, 2004) structure, underlying values and the mission of basic education are described. The students' prior knowledge and skills, as well as their notions of nature and experimental orientation, should be the starting point for science education that progresses towards laws and fundamental principles (FNBE, 2004). Experimental orientation means here physical (hands-on) and mental (mind-on) activities for the pupils. Empirical meanings of the concepts are essential.

In Finnish curriculum thinking, goals for physics and chemistry education are the most important part in the National Core Curriculum for Basic Education (FNBE, 2004). They are compared to legislation, and teachers should follow the goals while they are planning science lessons, teaching and evaluating. The list of contents, the syllabus, and descriptions of good performance are described in the framework curriculum for helping the

teachers in their work. In the Finnish lower secondary school curriculum, the goals for physics and chemistry can be classified as follows (Lavonen, 2007):

- goals for learning science subject matter,
- goals for learning scientific method,
- goals for learning the nature of science,
- goals for helping students to engage in learning science subjects (increase interest),
- goals for stimulating the pupils to become familiar with society and decision making,
- goals for cooperative skills development.

Fifthly, the autonomous role of a local authority and individual teacher is a characterising feature of the Finnish educational system that has to be taken into consideration in designing teacher education. Although there is a national level authority, the Finnish National Board of Education (FNBE), to carry out the implementation of education policy, local authorities have strong autonomy, a lot of freedom, power and responsibility. For example, schools and teachers are free to choose learning materials to be used in schools. At the same time, they are also responsible for their decisions, as national level inspection of learning materials was terminated at the beginning of the 1990s. A culture of trust can be seen at all levels of Finnish education through the autonomy of teachers in schools and teacher educators in universities. Traditionally, in Finland teachers are not only those who implement the decisions of higher level authorities, but they also take responsibility for making decisions about curriculum, through planning and writing the school level curriculum in more detail within national guidelines. Naturally, teachers take also responsibility for planning and implementing classroom activities as well as the evaluation process (FNBE, 2004; Lavonen & al., 2007).

Lastly, student feedback on the studies in question has been regarded as being important for further development of the programme. Their opinions have been considered as meaningful with regards to the evaluation and further development of the study programme. Student evaluations are collected twice

a year and the feedback is available when planning the implementation of the following teaching period. According to the feedback, students experience teaching practice periods as the most valuable for their individual development. In addition, small group activities with other student teachers were also of importance due to the opportunity for social interaction. However, even if practical tasks were valuable for all students and theoretical parts not easy to combine with teaching practice, the combination of theory and practice is of use for students. Students have found reflective activities hard to use for promoting their personal development. Based on student feedback, it is challenging to provide studies in such a way that students engage in educational aims and understand the meaning of different parts of the studies (Lavonen & Krzywacki-Vainio, 2007).

Physics teacher education at the University of Helsinki

Overall view of the teacher education programme

In this article, the focus is on the teacher education programme for prospective physics teachers who want to become qualified to teach physics and usually another school subject such as chemistry or mathematics at the lower secondary (grades 7-9, students who are 12-16 years old) and upper secondary school levels (grades 10-12, students who are 16-19 years old). At the University of Helsinki, as well as in other Finnish universities, master's level studies in physics are the main component of the teacher education programme. The studies in question embody a master's degree programme (300 cp.¹) which takes approximately five or six years to complete. The programme consists of subject matter studies in physics, i.e. studies in physics as a major (150 cp.), studies in another school subject such as chemistry or mathematics (60 cp.), and one year of pedagogical studies (60 cp.) including supervised teaching practice modules (20 cp.). In addition, language and communication studies are included in the programme (Figure 2).

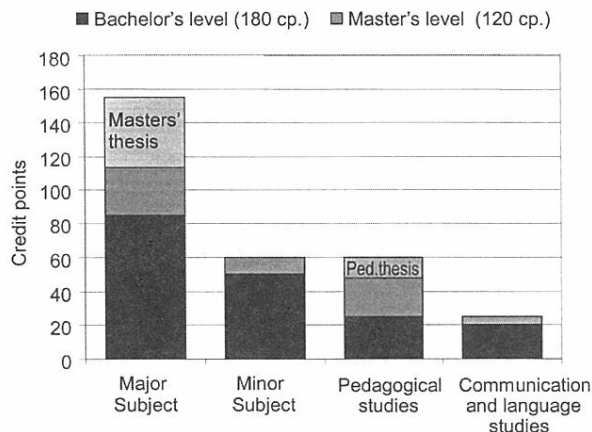


Figure 2. A structure of a master's degree of a physics teacher

Teachers' pedagogical thinking is emphasised as an organising theme in the teacher education programme at the University of Helsinki. The aims of teacher education are based on an ideal of a teacher who has a strong personal-practical theory. In other words, teaching is not only based on different knowledge areas, but a teacher should also be able to apply knowledge and skills as a part of pedagogical thinking when making decisions and justifying actions in the classroom. In order to be able to develop such competence, the main intention during pre-service teacher education is to help students to develop themselves and combine separate pieces of knowledge and skills as an integral part of their thinking as a teacher (Kansanen et al., 2000; Lavonen et al., 2007). Besides being able to act professionally in the classroom and being responsible for pupils' learning, a teacher should be able and willing to further develop their knowledge and skills during their teaching career. The learning of analytical skills for reflection has been considered one of the main tasks to be provided in the teacher education programme (Haritos, 2004; Trotman & Kerr, 2001; Younger et al., 2004).

The study programme can be described as being a highly academic way of educating future teachers, as cognitive knowledge and skills are strongly

emphasised in the programme. In practice, all student teachers complete both a master's thesis in their major subject (40 cp.) and a minor educational thesis (10 cp.) as a part of their pedagogical studies. The aim is to achieve high-level thinking and reflective skills, both in the subject matter and educational issues as well as skills for continuing professional development in the future. This involves not only deepening students' understanding of central concepts and familiarising them with research literature and methods in the field, but also involves giving students the opportunity to undergo experience as a reflective practitioner, as a professional who may act as a researcher in future work (see Lavonen et al., 2007).

Studies in Physics

The Department of Physics is responsible for organising courses in the subject matter and five closely connected courses, each with special aims related to PCK (for more see Koponen, Mantyla & Lavonen, 2004; Lavonen, Jauhiainen, Koponen & Kurki-Suonio, 2004). The basic undergraduate studies for a major or minor in physics includes courses that provide student teachers basic knowledge of physics and knowledge of its methodology, epistemology, and ontology. Master's level courses for student teachers concentrate on relevant subject matter knowledge and PCK. In addition, the studies orient the students in the teaching of physics. Students become acquainted with, for example: (i) the conceptual and process structures of the main areas of school physics; (ii) the most useful forms of representations, analogies, illustrations, examples, explanations, experiments and demonstrations; (iii) the history and philosophy of physics and its relations to society and technology; (iv) ways of representing and formulating the subject that make it comprehensible to students (for more see Lavonen, Jauhiainen, Koponen & Kurki-Suonio, 2004).

Below, as an example, two courses developed with special focus on the needs of physics teacher education are described in more detail. Other courses are as follows: Concepts and structures of classical physics (5 cp.), Concepts and structures of modern physics (5 cp.), History and philosophy of physics (8 cp.) and, Physics teachers' master's thesis seminar (6 cp.). Similar courses to these are organised in other Finnish universities.

In the course, Structures and processes of school physics (7 cp.), physics is examined as a subject taught in school. The goal of the course is to form an overall picture of physics needed in teaching and to organise its central topics in such a way, which is useful for teachers of physics. The central principles and themes, which organise physics as a discipline in schools, are scrutinised. Collaborative group working and different graphical network representations are emphasised. One aim of the course is to guide students in planning physics lessons from the point of view of physics knowledge structure.

In the course, Experimentation in the school laboratory (10 cp.), students study in small groups consisting of two or three students. In the interactive lectures, the methods of experiment-based teaching are discussed, and 19 experiment-based teaching units of school physics are introduced. Groups choose from these units any 5-10 units, which include certain experiments, and then they conduct them. The groups have to plan some of the experiments themselves. The designing of a unit also includes the constructing of a concept map, which represents the process of concept formation. The execution of a plan has to be based on well defined conceptual goals. The units have to proceed towards these goals, and so every experiment supports the concept formation. The units include both qualitative and quantitative experiments.

Pedagogical studies

The pedagogical studies are divided into three sections: general educational courses (13 cp.), courses in physics education (27 cp.), and supervised teaching practice periods (20 cp.). The main idea during the studies is to help students to combine educational theories with practice, their former knowledge about and of physics as well as their personal history (Trotman & Kerr, 2001). The need for combining theory with practice has been addressed by intertwining different courses together through timing and contents. In addition, portfolio assessment work is also used in order to help students in forming a coherent view of different aspects learned during the studies (Lavonen et al., 2007). Students may apply for the teacher education programme in every phase of their studies of physics. However, the

pedagogical studies (60 cp.) provided by the Department of Applied Sciences of Education are usually completed after the 4th or 5th study year due to the structure of the whole programme. The one demand is that students have to complete enough studies in the subject matter to ensure that they have the appropriate level of knowledge and skills before entering the first teaching practice period.

Typically, the following areas are discussed within courses in physics education: teaching and learning physics, students' conceptions and preconceptions, students' interest and motivation in physics, national and local curriculum and curriculum planning, teaching methods, ICT use in physics education, assessment, and research methodologies in physics education research. In addition to the subject specific approach, the education and learning process are discussed from different points of views during three general educational courses. For example, in the course in psychology of development and learning, students become acquainted with the basics of developmental and learning psychology, such as learning styles. In addition, students learn about learning difficulties and the structure of special education on the special education course.

Supervised teaching practice constitutes one third of the pedagogical studies. According to the feedback from the students, teaching practice is valued very highly compared to other courses in the teacher education programme. Teaching practice is a very practical and hands-on type of work and that explains, at least partly, why students regard it important for their development as a teacher. Many students feel, especially at the beginning of their studies, that "theory", i.e. research based knowledge about teaching and learning a subject is something that they must study, but which is not closely related to actual work as a teacher.

Studies are divided into four modules according to the four teaching periods of the university. During the first period, students become acquainted with the "theoretical basis" for the teaching and learning of physics. Students visit schools and observe lessons as well as participate in micro teaching sessions. The first teaching practice is located in the second period. The students plan teaching sessions in small groups, and teach in a classroom cooperatively. In the third period, the focus is on evaluation and reflection

at all levels starting with students' self-evaluation and ending with the evaluation of the operations of the school. Moreover, the students participate in an applied teaching practice, for example, in a vocational school. In the last period, the students attend their master's level practice. They also work on their educational thesis during the teaching practice, i.e. gather empirical data and analyse it, and thereafter, write a report on their small-scale research.

Formal teaching, regarding professional knowledge, is easily separate from teaching practice and, due to this, may not be the best way to combine "theory" and practice. Consequently, professional knowledge is linked to school practice in several ways. For example, during the lectures and seminars, a problem based approach is a way for students to get to know the theoretical framework through active participation. In practice, it requires the students to read reference books, web pages developed by us, research articles, and to attend lectures. Moreover, professional knowledge is combined with practice by using portfolios and portfolio assessment as a part of the studies. When working on portfolios the students have to consider both theoretical knowledge and practical work, possibly related to their personal experiences.

It is considered important, that a student teacher does not think that a single teaching method can solve all pedagogical problems in the classroom. For these purposes we have prepared a web based learning environment (<http://www.edu.helsinki.fi/malu/kirjasto/yto/yto/index.htm>), which introduces several instructional strategies suitable for physics education. In this environment instructional strategies are divided in four families: 1) experimental strategies, 2) instructional strategies that support social interaction, 3) instructional strategies that support information processing and 4) instructional strategies that support problem solving. In addition, a video library for student teachers (<http://www.edu.helsinki.fi/luovi/kokeellisuus/sivu1.fi.shtml>) introduces the use of instructional strategies through appropriate video clips. Each section starts with an introduction where the theoretical background of the strategy is given; for example, how the strategy supports learning, what the cognitive background of the strategy is etc. These environments will be developed further in the EU-funded Eu STD-web project.

Constructing teacher knowledge in the physics teacher education programme

The physics teacher education programme is organised according to different knowledge domains, such as subject matter and pedagogical knowledge. Traditionally, student teachers learn subject matter knowledge in the courses provided by the Department of Physics. Pedagogical knowledge has been at the centre of focus in the courses provided by the Department of Applied Sciences of Education. Furthermore, students should be able to develop their PCK through different courses provided by both university departments as well as through teaching practice periods. The programme includes the physics teacher's PCK composed of the five parts that Magnusson, Krajcik and Borko (1999) have outlined: orientation to teaching physics (science), knowledge of physics curricula, knowledge of students' understanding of science, knowledge of instructional strategies, and knowledge of assessment of scientific literacy. These areas of PCK have been allocated to the courses offered by both departments. However, integration of separate knowledge and skills in order to have a coherent entity of knowledge takes place primarily as an individual process. With the help of practical experiences, student teachers should integrate separate knowledge areas into a coherent knowledge base that constitutes a starting point for pedagogical thinking and for individual decision making (e.g. Hashweh, 2005; Kansanen et al., 2000).

In addition to the separate domains of knowledge, the nature of teacher knowledge, and the distinction between practical and professional knowledge, have been taken into consideration when constructing the implementation of the programme and the way of educating student teachers on university level courses. Students might confront contradiction between theoretical and practical knowledge, i.e. one challenge is to consider whether theoretical knowledge acquired through university courses is useful for acting as a teacher in the classroom. Therefore, students have also an active role as learners. They use portfolio work as a tool for reflecting on their practical experiences in teaching practice periods as well as their former school experiences. The aim is not only to make students analyse actions in the classroom within a theoretical framework, but also to think about their personal starting point

as a teacher regarding pre-conceptions about teaching and learning (Trotman & Kerr, 2001). From an epistemological viewpoint, it is a challenge for students to combine two forms of knowledge, practical and professional knowledge (Hiebert et al., 2002). The aim of portfolio work can be interpreted as transforming practical knowledge into professional knowledge. The requirements for knowledge to be professional knowledge, such as being public and precise as well as conceptualised, are essential to the process. It is a two-way process with a starting point based on particular practical experience as well as theoretical educational knowledge constructed beforehand.

The research-based approach in our teacher education programme influences both the contents provided during the programme, such as the literature to be read and the theoretical parts of the studies, and activities that students engage in, such as producing an educational minor thesis in physics education. The theoretical viewpoint is emphasised in the studies, but practical experiences in teaching practice periods are naturally part of the studies (Kosunen & Mikkola, 2002). Firstly, research activities can be regarded as a special feature of the programme. The role of students is active, meaning that they do not only consume but also produce educational knowledge by themselves. Even if only engaging in small-scale research, nevertheless students get acquainted with the research process and they have to think about the meaning of the requirements of professional knowledge. In addition, they usually integrate different knowledge domains in their educational thesis. Secondly, student teachers should acquire skills for self-evaluation and further development in work. There is not only one particular way to act as a teacher, and because of that, the programme is designed and implemented to support individuality in some extent. Already during the studies, students set aims for personal development, evaluate themselves, and start to form personal knowledge base. However, due to the minor role of classroom activities during teacher education, i.e. acting as a teacher in the classroom, the knowledge and skills learnt are put to a real test in a student's first teaching position after graduation. One might say that the emphasis of the programme is on meta-level thinking skills rather than on practicalities.

One of the challenges of university level teacher education, is to address the starting points of students, and to take into account the possible

controversy between the structure as well as the nature of teacher knowledge and students' epistemological viewpoints. Here, student evaluations of the content of the programme and their participation in the development of the programme help teacher educators to take starting points of students into consideration. Integration of different knowledge domains remains an issue, but through the help of practical experiences and a good understanding of the basic knowledge and skills, it can be addressed. As Carlsen (1999) has pointed out, the structural model of teacher knowledge domains is not a model for pedagogical reasoning in action or the way teachers use their knowledge, but of help for designing and implementing the teacher education programme. However, promoting reflective activities of students with physics as their major is a challenge. Academic teacher education is a good starting point for analytical thinking and it promotes meta-cognitive skills, but combining knowledge and skills acquired through the programme with personal experiences related to teaching practice is another story.

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Notes

¹ 1 credit point (cp) equals approximately 27 hours of academic work.

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ΠΕΡΙΛΗΨΗ

Η κατάρτιση των καθηγητών Φυσικής στη Φινλανδία: μια αναλυτική προσέγγιση του προγράμματος σπουδών

Το άρθρο περιγράφει και αναλύει πτυχές της εκπαίδευσης των καθηγητών των φυσικών επιστημών που διδάσκουν στο κατώτερο και το ανώτερο δευτεροβάθμια σχολείο στη Φινλανδία, με ιδιαίτερη αναφορά στο πρόγραμμα σπουδών για καθηγητές Φυσικής στο Πανεπιστήμιο του Ελσίνκι. Θεωρητικό πλαίσιο της ανάλυσης του προγράμματος σπουδών αποτελεί η γνώση την οποία απαιτεί η άσκηση του επαγγέλματος του καθηγητή Φυσικών. Η γνώση αυτή προσεγγίζεται κατ' αρχάς δομικά, από την άποψη δηλαδή των διαφόρων πεδίων που συναποτελούν τη γνώση του εκπαιδευτικού, όπως το συγκεκριμένο γνωστικό αντικείμενο, το παιδαγωγικό περιεχόμενο του συγκεκριμένου γνωστικού πεδίου, η γενική παιδαγωγική θεώρηση καθώς και τα σημεία επαφής μεταξύ των δύο αυτών πεδίων. Προσεγγίζεται επίσης από μαθησιακή σκοπιά με την αξιοποίηση της διάκρισης ανάμεσα στην πρακτική και την επαγγελματική γνώση του μελλοντικού εκπαιδευτικού.

Της ανάλυσης προηγείται η παροχή βασικών πληροφοριών σχετικά με το σχεδιασμό και την εφαρμογή του προγράμματος σπουδών για εκπαιδευτικούς στο Πανεπιστήμιο του Ελσίνκι, κα-

θώς και γενική ενημέρωση για τους σημαντικότερους παράγοντες που επηρεάζουν τη διαμόρφωσή του, όπως ο ρόλος που διαδραματίζει η αξιολόγηση του προγράμματος από τους φοιτητές και οι εθνικές στρατηγικές για την ανάπτυξη σχετικών προγραμμάτων. Ακολουθεί η ανάλυση του ίδιου του προγράμματος σπουδών σε ό,τι αφορά κατ' αρχάς το περιεχόμενο του στη Φυσική, ενώ στη συνέχεια η ανάλυση επικεντρώνεται στα παιδαγωγικά μαθήματα. Ιδιαίτερη αναφορά στο δεύτερο αυτό πεδίο γίνεται στην πρακτική άσκηση, στις γενικές αρχές διδασκαλίας και στη συναίρεση επιστημονικής με παιδαγωγική γνώση, που ουσιαστικά συγκροτούν τα επαγγελματικά εφόδια του αυριανού εκπαιδευτικού.