

Mathematics Teacher Training in Finland*

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1. Finnish schools and teacher education

Teacher education in Finland could represent for educationalists an ideal efficient case. On the other hand, among mathematics educators and mathematicians a significant part is not satisfied with today's teacher education. At the beginning of our paper we shall take into account the factors upon which educationalists are satisfied, and towards the end we shall discuss the factors which make mathematics educators and mathematicians unsatisfied.

Why does teacher education look to be ideal? Finland represents a type of welfare state. The government offers, mostly for free, all types of services, in particular to children and young people. This interest in children's and young people's growth brings to teachers remarkable respect. Teachers' status makes teacher education a favourite field for study, especially primary teacher education, where learning reading and writing has given a special merit to Primary School Teachers for about one hundred and fifty years. Education in Finland is not only free, but it is in addition well supported. Among others benefits, schools offer free daily warm meals and healthcare. There is free access to computers and printers and all computers are linked to the Internet. Students have daily access to computers, so that, among others, they can check their e-mails. Teachers have no restrictions to the number of photocopies they make and distribute to children as learning materials. Such materials and others, for art for example, are free.

So this interest of the state in the growth of children and young people attracts young people to apply for teacher education study. The interest in children and youth could be affected by the fact that the Finnish population is quite low with respect to both area and resources. According to Statistics Finland, i.e. the Centre of Statistics in the country, the population of Finland in 2002 was 5206000, which gives a density of 17.2 people per square kilometre of land. This is not enough reason for this care. This care is more related to historical factors and traditions. Taking care of children and young people has made schools a favourite work environment for many young people.

* This paper is a slightly revised one from an older version of a monograph published in 2004 and edited by Burghes, D. Series of International Monographs on Mathematics Teaching Worldwide. Monograph 2; Teacher Training, Műszaki Könyvkiadó, A WoltersKluwer Company and the University of Exeter, Centre for Innovation in Mathematics Teaching, pp. 83-105.

We do need to present in some details the school conditions in Finland to explore the elements which make schools a favourite work environment. The first thing to be noticed is that classrooms are well furnished and well equipped. Schools are open places, in both physical and social context. There are no walls to surround the schools, and visitors can enter the school through any of its open doors. Nevertheless teachers' work is not subject to any type of regular inspection.

Some details of facts related to minor factors of school circumstances can give the reader a clear image of the type of schools in Finland. A special characteristic of school classrooms is having wash basin and paper towels for washing hands and similar purposes. Classrooms, corridors, auditoriums, halls and bathrooms are always clean and warm, that is why children walk in socks inside the schools, which gives them the feeling of being at home. Every morning the teacher finds the blackboard and/or other type of boards well cleaned.

In Finnish schools, there is no formality in either clothing or in teachers' and students' communication. Nevertheless respect for teachers, especially in the case of primary schools, is very obvious. Finnish schools are not noisy, especially inside the classrooms. Rectors of schools are able to contact all children and teachers through out speakers in each classroom. This means that from time to time the rector can ask children and teachers to stop their activities, for a while, to hear to some urgent information. This happens quite rarely.

Today's school system of Education in Finland is a result of the related reform of 1970s. The major reform was in the establishment of the Comprehensive School upon the School System law of 1968. The establishing of the comprehensive school for grades 1-9 (age 7- 15) was a major factor, which brought Primary School teacher education to be a university responsibility. The effect of comprehensive school in teacher education will be discussed in greater detail later in this paper, but here we need to say a little about the comprehensive school and compulsory education in Finland. All children permanently resident in Finland are subject to compulsory education for a period of ten years, starting in the year of children seventh birthday. Compulsory education ends when the student reaches the age of 17, or when he or she has completed the comprehensive school syllabus, whichever first occurs. The network of comprehensive schools covers the entire country. Schools offering instruction in the first six grades are particularly close-set in order to avoid unreasonably long school journeys. For school journeys exceeding five kilometres, taxis are provided free of charge. Comprehensive schools provide free textbooks, notebooks, pencils, etc.

Comprehensive schools provide what is called in Finland **Basic Education**. According to the Basic Education Act of 1998, the main objective of basic education is declared as

"Supporting pupils' growth towards humanity and ethically responsible membership of society, and to provide them with the knowledge and skills necessary in life... The instruction has to promote equality in society and

pupils' abilities to participate in education and to otherwise develop themselves during their lives..." (Perusopetuslaki 628/1998)

The basic education syllabus includes at least the following subjects: mother tongue and literature (Finnish or Swedish), the other national language (Swedish or Finnish), foreign languages, environmental studies, civics, religion or ethics, history, social studies, mathematics, physics, chemistry, biology, geography, physical education, music, visual arts, craft and home economics. The broad national objectives and the allocation of teaching time to instruction in different subjects and subject groups and to student counselling are decided by the Government. The National Board of Education decides on the objectives and core contents of instruction by confirming the core curriculum. This is known as 'School Curriculum Basics'. Based on these Basics, each provider of education prepares the local basic education curriculum. The local curriculum is made by municipalities and schools.

Comprehensive school consist of two levels; Lower Level for grades 1-6 and Upper Level for grades 7-9. For the Lower level of Comprehensive School, i.e. Primary School, teaching is provided by class teachers and in the Upper level, i.e. Junior Secondary School, teaching is provided by subject teachers.

After attending comprehensive schools, children can attend either an upper secondary school or a vocational school for grades 10-12 (age 16-18), and both can lead to higher education. Teaching in Upper Secondary Schools and Vocational Schools is provided by subject teachers. A remarkable difference between upper secondary school and comprehensive schools is that, in upper secondary schools, students have to buy textbooks themselves and transportation to school is not the responsibility of the school. The reason here is that Upper Secondary School is not part of compulsory education.

Here we shall limit our discussion to General Education and leave Vocational Education outside this discussion. However, it is interesting to note that Vocational school teachers have the same education as those who teach mathematics at secondary Schools. Teacher education for Day Care Centres (Kindergarten) teachers is also outside this discussion, but we should mention that the number of hours devoted to mathematics and mathematics education for kindergarten teachers is slightly less than that for class teachers. Also we shall not discuss teacher education for special education in details.

On the administrative side, all types of schools are municipality schools and only Normal Schools, i.e. Practice schools, are state schools. The reason here is that, each Normal School is a part of a university and universities are state organisations.

In Finland, universities are the institutions in which all the teachers have their pre-service education. At the moment all teachers have to achieve education up to Master degree, with one exception. This exception is given to Day Care Centres (Kindergartens) teachers. Their education is of two cycles, the lowest offers Bachelor degree and the higher Master. In August 2005, the two cycles' system will be applied for other pre-service education of teachers to meet with the Bologna Declaration, signed in 1999 by 29

European countries, including Finland. Higher Education is well supported, as is teacher education. For 9 months each student receives a monthly bursary, currently 259 euros, and he or she can get a monthly housing support for about 170 euros. Students are allowed to earn up to 505 euros per month, and this sum is tripled to be 1515 euros in the three months summer holiday. In addition a student can get a monthly loan of up to 220 euros. All course books are freely available for loan from university libraries along with access to on-line electronic literature, so students need to spend little money on these resources.

2. Teacher education past and present in brief

To understand today's teacher education system, its organisations and teacher education significance in Finland, we need to briefly outline the history of teacher education and the history of its organisation.

Teacher profession roots in Finland go to the 16th century, when education was for church knowledge, and therefore it was given by clerics. The 17th century saw the establishment of first secondary schools, where teachers were deacons and graduates of these schools. In the 18th century teaching in secondary school was provided by university graduates and some of them were university teachers. The changes of the 19th century in teacher education form the foundation stone upon which today's system has developed. In this century a university professorship for education was established, and institutes for primary school teacher education and Practice Schools were established. The first professorship in education was in the *Faculty of Theology* in 1825. Primary school teacher education institutes were called *Seminars*, and this name was used until 1974. Practice Schools for secondary schools were called *Normaalilyseo*, i.e. Normal Secondary Schools. At the end of the 19th century and the beginning of the 20th century, education spread to include female education. Women's education had an effect on the growth of the number of female teachers (Raivola 1989, 94 -112). It is remarkable that in 1863, the first seminar in Finland was established in Jyväskylä, a town at the centre of Finland, and at this early stage this seminar had a female department as well as the male department (Nurmi 1974, 79-80). 1921 was the year of the Primary School compulsory education act and according to this act, in each village a primary school was established (Päivänsalo 1973, 10).

The second half of the 20th century saw the beginnings of moving primary school teacher education to universities. This was given first in a recommendation of Teacher's Preparing Commission in 1967. This recommendation was seen by the Commission as a way to establish comprehensive schools (Nurmi, 1974, 96). In 1969, more details about Comprehensive Schools and their teacher education were given in the report of the Comprehensive School Teacher education Committee (Nurmi 1974, 97). This Committee, among others, gave proposals for offering post-graduate studies to comprehensive schoolteachers. In 1974 Primary School teacher education was completely transferred to universities (Vuorenpää 2003, 96).

Since 1979 Primary School teacher qualification has been a M.Ed., i.e. Master of Education (Vuorenpää 2003, 117). This opened the door to Primary Teacher education becoming one of the most favourite fields of Study of Higher Education. The number of

applicants to Primary School teacher education is too high. According to Statistics Finland, in 2002 for 693 places the number of applicants was 13579, i.e. almost 20 applicants for each place (Statistics of Finland). This is not the case for mathematics teachers' recruitment! In the same year, 2002, the number of applicants to study mathematics, physics and chemistry was 8372 for 1416 places, i.e. almost 6 applicants for each place (Statistics of Finland). Most of these students study in a teacher education option. Mathematics teacher education is still as before, and for more than 200 years, the responsibility of mainly university mathematicians. Educational studies for mathematics teachers are provided by the Faculty of Education. This study can be continued up to Ph.D. in Education, but this option is not popular amongst mathematics teachers. By contrast, primary schoolteachers' interest in conducting post-graduate studies in Education is growing rapidly.

3. Who coordinates teacher education?

Universities in Finland have quite a high level of autonomy; the budget of a Faculty of Education is a part of its university budget, and this budget is a part of the Ministry of Education Budget.

The Ministry of Education forms different commissions and working groups to coordinate teacher education at different universities, and assist the development of teacher education. To prepare long-term or societally significant assignments, the Council of State is the responsible body for setting up a relevant committee. In addition, the Ministry of Education and the National Board of Education set up working groups primarily of experts (Hytönen 1996, 1). The outcomes of working groups, commissions and committees assist the co-ordination between universities in their planning for teacher education.

As an example of both coordination and autonomy, according to the decree of 1979, primary school teacher education for Masters Degree consist of 160 credits (Kohonen & Niemi 1996, 21), but this decree did not specify the number of credits for a particular course. This was to be solved inside each faculty. The same applies to the number of hours for obtaining a credit for a particular course. At the moment coordination has made primary school teacher education program more similar than before, but there is still enough elements to represent universities autonomy. One major element is related to teachers' freedom. The content of each course is that which the department/faculty approves upon a proposal of the responsible person of teaching this course.

Regarding teacher education organisation, each university (apart from the University of Kuopio) has a Faculty of Education. Each Faculty of Education has one or two teacher education departments. In each year, the budget of each department is affected by the number of students who obtained a Masters Degree in the previous year, and the number of students who obtained higher degrees; *Licentiate* and *Doctorate*. *Licentiate* is an option intermediate degree between Master and Doctorate. Teacher education at the University of Helsinki has a new administrative organisation this academic year, 2003-2004. The departments of the Faculty of Education have been absorbed into a larger Faculty of Behavioural Sciences. In the case of the University of Joensuu, the Teacher

Education Department has changed its name into the Department of Applied Education, and similarly at the University of Helsinki.

4. Are numbers controlled?

Yes, numbers of students for teacher education are controlled. According to the evaluative project KATU (Education Degree, Guidance and follow-up Project 'EDDE') of 1976, for each department of teacher education, a relevant number was recommended (Vuorenpää 2003, 129). This recommendation still plays a role of guidance to teacher education departments. In the years 1990-2000, the average number of students enrolled every year to become a Primary School teacher in each Teacher Education Department had been about 70 students. The exact number changes from year to year (Table 1), and from one department to another. These changes are necessary to meet with the number of expected possible vacancies at schools.

Year	Quota
1991	836
1992	820
1993	837
1994	784
1995	680
1996	630
1997	630
1998	630
1999	633
2000	630

*Table 1: Primary School Teacher Education Quota from 1991 to 2000
(Luukkainen, 2000, 223)*

In the years 2001-2003 the number of yearly enrolment has been raised to meet with the high number of retirements. Statistics for the year 2000 showed the need to increase the quota of primary school teacher training until the year 2010 by 500 (Luukkainen 2000, 280). Mathematics, physics and chemistry teaching is facing a more difficult problem. Towards the year 2010, more than 45% of today's teachers will be of retirement age. This situation is related partially to the distribution of the population of Finland. According to Statistics Finland of 2003, the population of age group 50-54 is 414 266, which is the highest number of population for such range of 5 years; for instance, for age group 0-4 the number is just 283195 (Statistics Finland). The large number of the population of age 50-54 and around is related to the baby boom after the wars. The main reason for the lack of teachers of mathematics, physics and chemistry teachers is the decline of students' interest in graduation in these fields; in the 1990s, for instance, universities had serious difficulties filling places for study in these fields. In 1999, only 65% of the mathematics quota was filled (Luukkainen 2000, 225).

5.1. Class teacher education (Grades 1-6)

Teachers of grades 1-6 are class teachers with responsibility for teaching all the school subjects for one class. In larger schools, there are teachers who teach normally only one of the two first grades. Most of these teachers have an initial education specialisation in teaching of these two grades. Also, in larger schools, there are teachers who normally teach only two grades, grades 3 and 4, or grades 5 and 6. It could be also that some teachers teach the last three grades, 4-6. The most common situation is to have teachers for grades 1-2 and others for grades 3-6. A teacher usually moves to the next grade as his/her students' progress through the school. In larger schools, specialised class teacher could be responsible for teaching one of the foreign languages, or one or more of the set of art and physical education subjects.

Class teacher education is a substantial part of the work of Faculties of Education. It is, as mentioned before, one of the most popular fields of study in Finnish universities. Those who do not succeed in getting a place usually apply again the following year. Some of the applicants even try more than twice. As part of their preparation, applicants often try to get experience as classroom assistants.

About 80% of the applicants are female. Regarding mathematics GEC examinations, only about 25% of the applicants attend mathematics examination on what is known as the 'long course', 55 % attend the 'short course', and 20% do not attend any GEC mathematics examination. This is due to the fact that there are only 4 compulsory GEC examinations: Mother tongue (Finnish or Swedish), second local language (Swedish or Finnish), foreign language and mathematics or real subjects. Real subjects are Religion, Ethics, Philosophy, Psychology, History, Geography, Physics, Chemistry and Biology. If a student takes examination in real subject he has to answer questions on two of these subjects of his choice. Students can take examinations in more than the compulsory 4 subjects. In this case students can take examination in both mathematics and real subjects. Most of the applicants for class teacher education have special interests in art and/or physical education, with music being the most appreciated.

Study at Finnish universities is a study of credits and not of years. In class teacher education, the major field of study is education and not subjects. The number of credits (cr) of study for class teacher is 160, including writing of the Master Thesis. This study takes about 5 years. A cr means the study for about 20 lessons (teaching hours), each of 45 minutes. More than half of these 160 cr, are devoted to educational studies. There are 9 school subjects which together form a minor called Multi Disciplinary Studies of only 35 cr. Mathematics and Mathematics Education is one of these 9 subjects, therefore they together have only about 3.5 cr (about 70 teaching hours). Each student has to choose at least one or two fields of specialisation. If the student chooses only one field, then she/he has to study this field for 35 cr; otherwise she/he has to study two fields for 15/35 cr each. These studies are also of minor status. A field of specialisation can be related to any school subject, but it can be an educational study. One of the most popular fields of specialisation is 'Teaching School Beginners'; i.e. teaching of grades 1-2. This study includes 1 or 2 cr in Mathematics Education. Class teacher education ends with a master thesis in education. Less than 5% of these are related to mathematics education.

The data presented here is taken from the University of Joensuu (Kasvatustieteiden tiedekunta 2003). Today the programs of Teacher Education Departments in Finland are very similar. Therefore we shall use the University of Joensuu as a main reference when we speak about the Teacher Education Program. We have to add that, in the case of the University of Joensuu, class teacher education related to mathematics is quite exceptional, but this is a small part of the whole class teacher program. Using one university as reference makes our discussion more concrete.

5.2 Class teacher mathematics and mathematics education

Class teacher pre-service education in mathematics and mathematics education is different from one university to another. It depends on mainly the person who is responsible for teaching. The University of Joensuu is a special case. Instead of getting 3-12 cr, students get 4 or 7 cr. About half of the students choose 7 cr.

The usual pattern for mathematics and mathematics education in Primary School teacher education is to have about 2 cr (30-40 teaching hours) for studying mathematics and an equal amount for mathematics education. In both studies, and in most departments, this amount is divided into two equal parts, one part for lectures and the other one for practices. Practices usually take place in groups of about 15-20 students. In the case of the mathematics course, the content could be mainly in studying Mathematical Logic, Sets, Relations and Functions, or just dealing with primary school mathematics content, or some thing between. It could also be a study in which the main part is related to studying the nature of mathematics, mathematics as an element of culture and the development of mathematical ideas.

The study of mathematics education is also varied. It could involve the study of mainly psychological theories and their relation to mathematics education; it could be a study in which games or problem-solving is the core; it could be also a study of mainly mathematics teaching objects and the way to achieve their understanding. It also could be a study related mainly to using Information Technology in teaching mathematics. For each course literature is provided, where its status is also varied. In some cases it is obligatory, which means that examinations include questions related to it. In other cases literature is given as an extra resource of knowledge. In the case of the course of mathematics, practices could be on solving mathematical problems, those given normally before each lesson. But, these practices could be arranged in other forms like seminars. In the case of Mathematics Education course, practices could mean seminars or something else; for example, it is common to organise activities related to games, problem-solving, manipulatives, visualisation or exploring the possibilities of using information technology.

At the university of Joensuu there is an option to choose extra courses on Mathematics Education for a total of 3 cr: 1 cr for Geometric Thinking, 1 cr for Algebraic Thinking and 1 cr for Strategies for Effective Teaching of Mathematics. Students can choose one or more of these three courses; the most common is to choose all of them.

5.3 Specialisation on mathematics for class teacher

Specialising in mathematics was not popular among class teacher students until 1996, with one exception and this was the case of the University of Joensuu, since the academic year 1992-1993. In 1996, the Ministry of Education announced the National Joint Action Programme for Developing Mathematics and Science (LUMA). One of the aims of this project is to offer 15 cr in mathematics or science to about 15% of class teacher students (Ministry of Education 1999, 41). Such a percentage is now almost achieved in most universities. In the case of the University of Joensuu, about 80% of class teacher students choose mathematics as a specialisation study for 15 cr, and half of them continue their study to 35 cr. The University of Joensuu has played a major role in developing mathematics education in Finland. For this role, the University was nominated in the year 1994 as the Centre of Excellence in Mathematics Teacher Education.

The 15 credits for specialisation can be different from one department to another. In the case of the University of Joensuu, these 15 cr include 4 or 5 cr on the so-called Special Courses on School Mathematics. These courses could include: Geometric Constructions (1 cr), Experimental Geometry (2 cr), Numeracy (1 cr), Computer-Based Instruction (1 cr). The other 10 cr are on Pure Mathematics. They are chosen to be relevant to teacher education. These credits could be: Arithmetic and Algebra (3 cr), Mathematics Nature (2 cr), Discrete Mathematics (3 cr), Introduction to Analyses (3 cr).

6. Teacher education of mathematics teachers (Grades 7- 12)

Mathematics teaching in Secondary schools (Grades 7-12) is provided by subject teachers, those who have received their education at the Faculty of Mathematics and Natural Sciences, referred to here as the Faculty of Science. In most cases, students train for mathematics teaching and physics teaching and/or information technology. In addition, he/she could train to be a teacher of chemistry. Mathematics might be not the major field of teacher pre-service education, especially for those who are teaching in Grades 7 - 9. It could be the second and, in some Junior Secondary Schools (Grades 7 - 9), the third field of specialisation.

When mathematics is the major field, students get not less than 60 cr in mathematics, otherwise the study could be for only 35 cr or in some cases 15 cr. As most of mathematics teachers have 35-60 cr, they have education in mathematics for about 1200-700 teaching hours. Less than 25% of mathematics teachers' have only 15 cr (about 300 teaching hours).

On the other hand, all mathematics teachers have 35 cr in education at the Faculty of Education. These 35 cr include a modest part on Mathematics Education of about 3 cr. The 35 cr include, as well, 3 cr for some type of seminars which could be related to Mathematics Education. Through these seminars, a student has to develop some kind of research, often a limited qualitative study. All teachers of mathematics have got teaching practice of about 10 cr. One of these cr is devoted to specialised teaching of a subject other than the major subject, and two of them are outside the university's practice schools. These two credits might be in an ordinary city school, or another school, inside or outside the country.

Teacher education at the Faculties of Science ends with a Master thesis in the major field of study (12 cr). In recent years a Master thesis on so-called *didactical mathematics*, has been approved in some Faculties of Science as equivalent to the Master thesis in mathematics. A mathematician, not a mathematics educator, supervises this type of thesis.

Typical courses of mathematical study are: Analysis, Linear Algebra, Logic, Differential Equations, Geometry, Metric Geometry, Metric Spaces, Complex Analysis, Matrices, Probability Theory, Discrete Mathematics, Topology, Functional Analysis, Complex Analysis and Mathematical Computing.

7. Practice schools

Practice schools have a special status in Finland. Since the 1860s these schools have existed under different names although their main goal has not changed; namely, training teachers.

Before 1974 there were two types of Practice Schools: those for training subject teachers were called 'Normaalilyseo' and those for training Primary School teachers were simply called Practice Schools. 7. In 1974 these schools were eliminated to make way for a new system, a unified Normal School, as a part of the Faculty of Education. As it is known in the history of education, the French name 'Écoles Normales' was the name used for the newly established institutes for teacher education of primary schools on the second half of the 18th century. The word 'Normales' was related to the targeted norms which education has to provide for the general public. These norms did not include the development of abilities, but mainly the appreciation of the way of life designated by the authorities of that time (Dottrens 1966). Normal Schools in Finland are considered a necessary environment to integrate the theory and practice of education.

8. In-service Education

In-service education of teachers is well organised in Finland. Different organisations provide different types of in-service education. For instance, the ministry of education and the national board of Education provide different types of in-service education in mathematics. Also local educational authorities of different levels up to school level provide in-service education. Universities and teachers' associations provide in-service education on mathematics teaching. These associations provide in-service education at different levels, local and national level. Each university has a centre for continuing education and each province a Summer University. Both provide different types of education including in-service education for teachers. Also, what are called 'free institutes' and 'civil institutes' can provide in-service education for teachers. In this brief survey, we have mentioned the main organisations providing in-service education for teachers but this is not a complete list of providers. In-service education is sometimes provided free, otherwise teachers have to get funding from the teacher's school to pay for it.

It is remarkable that in some cases teachers themselves pay for participation in in-service courses of interest to them. This is an indication of how teachers in Finland are interested in their profession and its development.

9. The reasons behind the success in PISA

The results obtained in PISA studies, especially that of the year 2003 was a reason to reflect on our strengths and weaknesses in education, and mathematics education in particular. At the PISA conference, of Helsinki 2005, my presentation was focused on the reasons behind the success in Mathematics of PISA studies. In this context, I have presented our strengths, among others those of our teacher education. In the next chapter we shall focus our discussion on our weaknesses in mathematics teacher education. The present chapter is a new chapter. It is written after the conference to include some of the outcomes of my reflection on our strengths. From one hand this chapter can be seen as a separate and extra unrelated part to the paper, but on the other hand most of its content can be obtained by the reader himself from analysing the previous 8 chapters.

There are 7 main reasons behind our success in PISA studies, and these reasons can be divided into two sets. The first set includes 4 elements: the success in pre-service education, teaching profession culture, the success of in-service teacher education, and the hard efforts to develop mathematics education, including the role of the University of Joensuu. The other set includes the next 3 interrelated elements: the welfare of schools, the pleasant work environment of schools, and school everyday life traditions.

The 8 chapters discussed before helps us to demonstrate in some details some of the mentioned above two sets of reasons. This may, partially, look as a repeating, but on the other hand it is a synthesis, where the aim is to bring together the factors behind the success in PISA. The success in pre-service teacher education has mainly two aspects: the success in keeping high the teaching qualification, and the success in recruitment of motivated students. All the school teachers in the country must get a master degree M.Ed. in the case of primary school teachers (Grades 1 - 6) and M.A. or M.Sc. for secondary school teachers (Grades 7-12). The success in recruitment is to only a satisfactory level in the case of mathematics teacher education, but it is one of the most popular studies in higher education in the case of Primary teacher education.

Primary School teachers have special status in Finnish society. Mainly, three socio-historical factors have brought this special status. For about 150 years, learning reading and writing has been a merit of primary school teachers. This merit was before given to a holy organization: The church. According to the 1921 '*Primary School compulsory education act*' in each village a primary school was established. Primary teacher then had become the enlightening candle of each village. Finally, by 1974, primary school teacher education was completely transferred to universities. This brings further interest on primary teacher education. It is to notice that in each town, and each village, still exist two main streets: Church Street and School Street.

About teaching profession culture, it is to notice that teaching, for the majority of teachers, is a mission, where teachers' interest in students learning has long tradition.

This can be seen from two sides: one is the interest of teachers in developing themselves. The second is in the cozy approach of a teacher in assisting an individual student, among others in assisting students in their learning tasks. In Finnish schools, there is no need to think about punishment of students. Physical punishment cannot come to teacher's mind, even shouting is not needed. Punishment and controlling are not the characteristics of teaching profession; the aim of teacher's work is to support students' growth.

In this chapter we have discussed in some details only 2 elements of the first set of reasons, mentioned above. The third element, the success in in-service education, we have discussed enough in the previous chapter, and therefore there is no need to discuss it again. The fourth element, the hard efforts to develop mathematics education, including the role of the University of Joensuu, deserves more discussion, but we leave it to a special paper to appear on the Proceedings of ICME-10, Tenth International Congress on Mathematical Education, National Nordic Commission. The paper's title is Mathematical Clubs: A way to develop mathematics education.

Let us now discuss the three elements of the other set of reasons. Through our discussions in the first chapter of our paper, we have dealt in some details of the welfare of Finnish schools, among others we mentioned to offering warm meals. Now we need to put emphasis on another, partially, welfare school's aspect, that is the relatively low number of students in Finnish classes. This has different impact on social relations on the class, and on the learning of each individual.

From the social side, the low number of students makes teacher and students close to each other. The class lunch, with the teacher, looks like a lunch of a big family, and the type of lunch is similar to ordinary family lunch. Besides the warm dish, it includes salads, dessert and drinks, especially milk. The food is always fresh and well prepared, that is why students like it. From the learning side, the low number of class students, brings to teachers a possibility to take care of each learner, especially those who showed weakness in some area. In addition, teachers of special needs (M.Ed.) are able to provide effective support to these students, also individually in special teacher's room. The small number of class students gives students to know each other better, where in learning some are able to help others.

About the pleasant work environment of schools, we have mentioned in the first chapter to the fact that, in Finnish schools there is no inspection. Of course this saves money, but it mainly gives each teacher the feeling of being free and responsible. Teacher has as well freedom in building his own curriculum, based on the curriculum basics published by the National Board of Education, and the more detailed curriculum accepted by his school. Every teacher takes part in building school curriculum, and teachers are represented in writing the National Curriculum basics, which is not a detailed one. Every teacher as well has freedom in choosing the needed textbooks for his class, among the available textbooks of different publishers. Freedom gives every teacher active role, which makes him highly interested in his work, and offers him a chance to develop his experiences.

About school everyday life, there is a need to add some of special characteristics of school everyday life. Every teaching hour is 45 minutes. In the 15 minutes break between each two lessons, the teacher open a classroom window for air refreshment, even in winter. At break time students, especially of grades 1-6, have to leave the classroom to schoolyard. In turn, one or more teacher must be at the schoolyard as observer.

Finally, we have to remember that the dispersion of Finnish students is smaller than in other countries. This has been not only seen in PISA studies, but as well in other comparative studies before. This can be seen as a result of implementing the principle of equality accepted for comprehensive school, but the equality of the comprehensive school law of 1998 is just a reflection of Finnish traditions in society. The results of PISA show that there is no significance effect of socio-economical background of students on their learning. This is not unexpected result, in Finland there is no interest in the so-called private schools and private lessons are something unknown. The reason here is related to long traditions of trust on public schools and teachers. Parents are sending their children to schools not only for learning, but for supporting children's growth. Schools are not only for preparing children for future, but schools are also for present children's living. Parents trust teachers in taking care of their children, and teachers are indeed interested in assisting the growth of every student, especially those of some weaknesses. That is why the dispersion of Finnish students is smaller than in other countries. This is on the other hand reflects one of our main problems in mathematics education, the need for more care of gifted students. As we came to discuss our problems, we shall move to discuss our weaknesses in mathematics teacher education in the next chapter.

10. Teacher education problems: Discussion, proposals and questions

We have discussed in this paper different aspects of teacher education in Finland related to mathematics education. This discussion represents facts about teacher education in Finland, where the teaching profession is highly appreciated. All schoolteachers receive their training at universities and obtain a Masters degree. The number of applicants greatly outnumbers the places available. Teacher education involves university practice schools, where theory and practice are engaged to offer the best for teaching practice. School life offers an appreciated work environment, which attracts young people to choose the teaching profession. So are there any problems in teacher education? The answer is that there are serious problems, and solving them is not an easy task. The most serious problem is related to the content of the class teacher education program and, in particular, the mathematics teachers training program.

10.1 Primary teacher education problems

For class teacher education, students study for about 5 years to get a Masters degree and be qualified teachers, but looking carefully at the program shows that mathematics and mathematics education study, for most of these students is not more than 10 days study of 8 hours a day out of the 5 years of study. Even in the case of having only 6 teaching hours a day, as it is common today, the number of days might not exceed 13 days.

Details of the Class Teacher education program show that this program is more relevant to a researcher in education than to a teacher. Through the 160 cr of study for M.Ed, the minimum number of credits in Education is 75, i.e. 47% of the credits of study. Appendix 1 (Kasvatustieteiden tiedekunta 2003) gives more details of these 75 credits in the case of the University of Joensuu.

Beside these 75 credits, which offer a major in education, students can choose in addition another 30/35 credits in a field of education as a minor for specialisation. This specialisation might even be in 'adult education'. Appendix II (Kasvatustieteiden tiedekunta 2003) gives more details of educational minor studies. When choosing 35 credits in education as a minor study, the number of credits jumps to 110, which is of about 69% of the M.Ed program credits. Beside the 75 obligatory credits in Education, there are 13 obligatory credits, called General Studies, out of which at least 7 credits are for assisting students to work as researchers in education and 5 cr are related mainly to teaching profession. Appendix III (Kasvatustieteiden tiedekunta 2003) provides more details of these studies. There are also 2 compulsory credits for all primary school teacher education students under the name 'other studies'. These 2 cr are also in education 'Central Issues in Special Education'.

The previous details mean that out of 160 credits at least 84 credits, i.e. 52.5%, are for educational studies, most of them are oriented for research in education (Appendix I). The number of credits for educational studies could be as high as 119 credits, i.e. 74% if choosing 35 credits minor in education. It is remarkable that only 14 credits out of all credits in education are of practical means for the teaching profession (Appendix I). These 14 credits are related to teaching practice. The total number of credits for mathematics and mathematics education is 3 to 4, i.e. from less than 2% to 2.5 % of the 160 credits of study. In terms of time, 3 to 4 credits mean 60-80 teaching hours. This represents 7.5 to 10 days study out of a total of about five years. This modest part of mathematics and mathematics education study has to be enough not only for teaching mathematics in the first 6 years of comprehensive schools, but also for writing detailed mathematical curricula and mathematical textbooks for these 6 years. It could be as well enough to make later a Ph.D. thesis in education with a topic related to mathematics education.

Thus, the main problem in teacher education of class teachers is that the program is more relevant to the preparation of a researcher in education than to a teacher! This was justified by the so-called academic education of class teacher. In the past, the core of study was on the subjects of primary schools and not the study of education. We now see the opposite in primary school teacher education at universities. Today's study can be regarded as relevant only to those who intend to continue their studies as researchers in education. Is it sensible to sacrifice primary school teacher education in order to obtain education specialists? We also have to ask: "For whom and for what we are preparing these specialists?"

What about the future? According to the Bologna Declaration, university education has to graduate students in 3-4 years and offer them a Bachelor degree. Theoretically, this can

help to make teacher education for B.Sc. more relevant to teacher preparation. Practically this is difficult to achieve. The program of teacher education at the moment has 30 years of traditions. It has brought a large number of educationalists, who are leading all the activities of the faculties of education, including teacher education. Therefore it is difficult to ask educationalists to give up on the program they have planned and used for many years for teacher education. It is difficult to change what has become a tradition.

Another problem in class teacher mathematics is related to its modest status with respect to art and physical education. In comparison with art education and physical education, the set of Visual Arts, Music, Crafts and Physical Education have about 4 times as many credits as mathematics. Before 1993 these disciplines had even more, but the University of Joensuu had led at that time a reform, which brought a slightly more balanced situation with other fields of study, and mathematics in particular. In Primary Schools in Finland, art and physical education have had for long time a special place. Most students who apply to class teacher education are mainly interested in teaching these subjects. In some cases, this interest goes back to their early childhood. In addition, some department of teacher education include in their entrance examination an opportunity to give a demonstration on one of the art subjects. This gives reinforcement to the applicant's image about the place of art in Primary School. Also the primary school curriculum gives reinforcement to this image. At schools, 'musical classes' are well appreciated and popular where children have more lessons in music than in other classes. There are also different types of clubs for arts and physical education inside and outside the school. The opposite is true in the case of mathematics; the time devoted to mathematics is just 3-4 lessons a week. Mathematical class is still a strange idea, and mathematical clubs were difficult to find until 1988 (Malaty 1996). There are no activities related to mathematics education outside schools.

In the UNESCO survey of 1986, the collected data from 27 European countries showed that for teaching mathematics at schools, Finland devoted less time than any other European country included in the survey (Unesco 1986, 35 and 61-71). Despite all the attempts to raise the number of hours devoted to teaching mathematics in Finland, nothing significantly has changed in this concern.

As we mentioned before, establishing mathematical classes, or establishing a class for students with high intellectual abilities, is difficult to get appreciation in Finland, but why? The reason is related to traditions, which are reflected on the Basic Education act mentioned at the beginning of this paper. In this act, we find a special idea of equality,

"The instruction has to promote equality in society and pupils' abilities to participate in education and to otherwise develop themselves during their lives"
(Perusopetuslaki 628/1998)

Whereas competition between children for enrolment in musical classes is appreciated, establishing mathematical classes is not a welcomed idea. Also the Basic school act does not put emphasis on mathematics and science education for comprehensive schools (Grades 1-9). The main goal is declared as

"supporting pupils' growth towards humanity and ethically responsible membership of society, and to provide them with the knowledge and skills necessary in life"
(Perusopetuskilp 628/1998)

Such an objective cannot be rejected by any educationalist, but the problem is in the idea behind it, which excludes putting emphasis on teaching mathematics and science education.

Regarding specialisation, before the beginning of the 1990s almost 100% of students chose as a minor for specialisation one or more of the following disciplines: Visual Arts, Music, Crafts and Physical Education. At that time not more than 2% of students chose mathematics as a minor field for specialisation. Today the situation is slightly better with about 15% of students choosing mathematics as a field of specialisation for at least 15 credits. It would be ideal to allow specialisation in two different disciplines: one from the set of art disciplines and physical education and the other from other disciplines, including mathematics.

What about the future? Implementation of the Bologna Declaration gives 3-4 years for study for a Bachelor degree. This is sufficient for graduating students to be primary school teachers. In this case, 3-4 years study can be used to graduate students to be teachers and not yet researchers. This could be a chance to make reforms in primary school teacher training. Bringing back school subjects and their teaching as a core of teacher education is necessary. Education study has to fulfil only a functional role at this stage and not be an aim in itself. Post-graduate study for a Masters degree is another question, and this has to be a cycle for preparing researchers. The question now is: "Are educationalists ready to give up on teaching education as a major for the first cycle, or not?" In the last 30 years, the name of primary school teacher education institutes has changed from Seminars to Departments of Teacher Education, and they are now changing to 'Departments of Applied Education'. This means that teaching is regarded as an application of theoretical knowledge of Education. Is it possible to see teacher education as something more than applying sciences of education? Also the naming as 'class teachers' instead of 'primary school teachers' has meant teaching all school subjects by one teacher and even for all the 6 grades of primary school. Is that the ideal case? Large resources are used at the moment to give education in art and physical education for all primary schools, but can all class teachers be musicians, visual artists, craft artists and sportswomen/sportsmen? In practice, and at least in larger schools, some teachers teach one or two of these subjects to all classes. This means that, for a majority of teachers, the study of all these subjects is not relevant.

Also, at the moment there is specialisation in 'Teaching for Beginners', i.e. teaching for grades 1 and 2. What about teaching for upper grades (Grades 5-6)? Don't these grades also need specialisation?

10.2 Special teacher education problems

Despite the fact that the pre-service education of special teachers in mathematics and mathematics education is similar to that of primary school teachers, they get jobs in

either; the lower school of comprehensive school (Grades 1-6) or the upper school of comprehensive school (Grades 7-9). The problem here is that the modest education they get in mathematics is not enough to teach mathematics to students of grades 7-9 (age 13-15). Are educational studies enough to teach any subject for any level?

Regarding special education there is a question related to gifted students. Is their teaching of the same importance as that of students with special needs? Do they also need a specialized teacher? Gifted people are the keys for human culture development, including the development in taking care of weak students.

10.3 Mathematics teacher education problems

The problem of subject teacher training programs is related to the fact that the number of credits related to mathematics education is mainly 3, i.e. about 60 teaching hours. These 3 credits are: Special Issues in Teaching and Learning, 2 cr, and Special Educational Issues in Teaching and Learning, 1 cr (Appendix I).

The program of educational studies of a subject teacher is the same as the first 35 credits, out of the 75 obligatory credits in education for class teacher education (Appendix I). Therefore some of these credits are given, in a whole or partially, in a larger mixed group of class teachers and subject teachers, regardless of the subjects of specialisation. This shows how the centre of interest in these 35 cr is related to general issues of education. The heading of courses in Appendix I can help in exploring this fact.

The other major problem in mathematics teacher education is that it prepares teachers to teach mathematics and one or more other subjects. The most common is to teach mathematics, physics and chemistry, especially in the case of teaching grades 7-9. Even when there are 3 teachers at the same school, each teacher teaches all 3 subjects. This makes teaching in grades 7-9 quite similar to class teaching as the teacher teaches all of the 3 subjects to one or more groups of students. This does not give opportunity to concentrate on developing subject teaching. In particular, it does not permit the checking of teaching strategies of a topic by teaching it to higher number of different groups. This is also a problem of tradition. In the past, schools were small in size and therefore advertisements for teaching posts had asked for a teacher for mathematics, physics and chemistry. Now, even in the case of large schools, advertisements still ask for teachers with the same qualifications as before.

The third problem, which is a result of the two previously mentioned problems, is that those teachers whose major study was physics or chemistry have not got any credit in mathematics education. As a result these teachers have got 35 credits of mainly general issues in education and have no credits in mathematics education. They also have got, at most, one credit on mathematics teaching practice.

Mathematics teacher education also faces the problem of drop out. Only about half of those who started their education to become mathematics teachers finish their study. This on one hand reflects how mathematics teaching does not attract enough students with

high ability, and on the other hand, reflects the need for change in the style of teaching mathematics for students.

10.4 General problems related to teacher education in Finland

There are other problems in teacher education that are general. Such types of problems are found in class teacher education as well as in mathematics teacher education. Also there are problems for both types of teacher education, which are related to higher education in a whole. For instance, the age of applicants for teacher education is high, but this is also the case for applicants to other types of higher education. In 2002, the median age of applicants to the faculty of education was 21.7 years (Statistics Finland), whereas the median age of applicants to the faculty of Science was 20.2 (Statistics Finland). For the University of Joensuu, in the year 2002, the mean age of students who started their study to become class teachers was about 23, where only about 5% of them were less than 20 years old, and similar percentage were over the age of 30. Age 20 or younger is suitable for starting learning effectively but age 23 is more suitable as the age to be ending higher education study that starting it.

One of the reasons for this high starting age is that students try to get a place for study in particular field of a specific department in higher education. When this attempt fails once, they normally try again the following year, and this might be repeated several times until they got a place of their choice, or until they changed their targeted department. In the case of primary school teacher education the GEC qualification is not enough and there is a need to collect points, perhaps from working with children or working as a teaching assistant at school or some relevant activity to obtain points. In the case of primary school teacher education there is a need to stop the demands of obtaining such points. It could be ideal to rely on GEC grades and some test of aptitude to the teaching profession. In this case it would be best to give a teaching demonstration.

The other general problem is the effect of graduate number on the size of the budget of each university department. This has an effect on the number of teaching hours of each credit. At the moment this amount is as low as about 20 teaching hours. Ten years ago it was common to give 30 teaching hours for one credit (Kasvatustieteiden tiedekunta 1993). Today's 20 teaching hours for a credit are calculated as 40 hours. In an accurate expression these 40 hours are called 'work hours'. This has effected on both the quantity and quality of study. A well-known Finnish mathematician, Tuomas Sorvali, has made a comparison of mathematics teacher education in the year 1975 and the year 1995 (Sorvali 2004, 2). He has come to the conclusion that today's studying of mathematics to the highest level, i.e. the *laudatur* level of about 60-70 credits, is the same as studying for only *cum laude approbatur* of about 35 credits in the year 1975. Simplifying the study of mathematics for initial education of mathematics teacher could be accepted under one condition, and this is to establish a genuine study of school mathematics and its teaching. At the moment simplifying is mainly for its' own sake, or to make the study easier. It could be a procedure to shorten the time needed for graduation, and it could also save money. Such saving was not seen until the beginning of the 1990s at a time of economic depression, but this has continuing and even increased after economic recovery and in a time of flourishing.

The tendency of decreasing teaching hours has had an effect on teaching practice. Ten years ago the number of credits for teaching practice was 20 cr; today it is about half this amount. Also the quality of teaching practice supervision has declined. There was a time when both mathematics teacher student and class teacher student got enough supervision from mathematics educators. This supervision included planning meetings for groups of students to assist them in their planning for the units they were going to teach. The meetings had minimum number of hours for each group and supervision included observation of a definite number of lessons as a minimum for each student. At that time, at the end of each observed lesson, feedback was given in the form of a discussion between the mathematics educator, school teacher, student teacher and other student teachers who had observed the lesson. Also the teacher student was able to meet with the mathematics educator before the lesson to consult on her/his plan for teaching the lesson. Now most of this provision has disappeared. At the moment there is still some kind of mathematics educator supervision, but not at the previous level.

Financial considerations have also affected the education of Normal School teachers and teacher education subject educators. Before the early 1990s, they were entitled to one academic semester as a sabbatical when they had worked for 7 years. This was discontinued and has not been reinstated.

Both primary school teacher education and mathematics teacher education have common problems, affected by school education. Where primary school (Grades 1-6) puts emphasis on art and physical education, in secondary school, and particularly in the upper secondary, the emphasis is on languages education, especially foreign languages. As mentioned before, the GEC examination includes only four disciplines, three of which are languages examinations. The fourth can be mathematics or what is called real subjects. There are some indications that in the near future the GEC might have only one examination of obligatory status, the mother tongue examination, and the other three can be choose from 4 examinations: the second national language, foreign language, mathematics or real subjects. This would mean that the number of students who take examinations in mathematics might increase a little.

11. A way to develop mathematics teacher education

In the last chapter we discussed our problems in mathematics teacher education, where we can as well find some ideas for solving these problems. One of the main problems we face is the program of primary school teacher education, especially the modest part devoted to school subjects' studies, and mathematics in particular.

Table 2 represents the situation we still have till the moment. In this table teaching practice is not taken in account as an educational study. Mathematics and mathematics education is one of the set of fields named "9 school subjects", which includes the 9 school subjects and their education.

Field of study	Number of credit hours	%
Education	63	39.4
9 school subjects	35	22
Mathematics and Mathematics Education	3 - 4	1.9 – 2.5
Teaching Practice	10 – 12	6.3 -7.5

Table 2: The percentage of obligatory studies in primary teacher education

From this table, we can see that education has about 2 times as the 9 school subjects and their education together. Educational studies have about 6 times as the teaching practice, and about 15 to 20 times as mathematics and mathematics education together. In fact, the study of all the 9 school subjects and their education takes about 5 months of study. This is a modest part of about 5 years of study for primary school teacher education.

The Bologna declaration can offer a help to solve this problem. As the study has to be of two cycles, the lowest cycle which lasts 3 years can be devoted mainly to preparing teachers, where school subjects and their education can be the major of study and the higher cycle of two years can be devoted completely to the study of education to prepare educationalists. Table 3 represents a proposal for the lowest cycle.

Study	%
Teaching practice	15
Mother tongue	15
Mathematics and mathematics education	15
Science and science education	10
Humanistic sciences	10
Art, Physical education and their education	15
Education	20

Table 3: A proposal for the lowest cycle study of primary school teacher education

This proposal from one hand keeps education as the major of study for primary school teachers, and from the other hand it takes care of first needs of every future teacher: the understanding of what she/he is going to teach. In addition, understanding the nature of school subjects and their education is of great help in developing education as a science.

Finally, this paper has mainly dealt with both strengths and weaknesses in teacher education in Finland. The success we have got in PISA is due to complex factors of strengths, including teacher education, but the way is still open for higher achievements, where developing teacher education is one of the main tools to reach this goal.

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Appendix I

Obligatory Educational Studies in Class Teacher education Program

I. Teacher's Pedagogical Studies (35 cr)

Education, Training and Culture (9 cr)

- Teaching and Learning Foundations, 2 cr
- Orienting Teaching Practice, 2 cr
- Introduction to Education, 2 cr, 20 Lectures
- Life Cycle and Human Development, 2 cr
- Introduction to Special Education, 1 cr

Learning Environment and Interaction (9 cr)

- Pedagogical Ethics: Ethical and Philosophical Aspects in Teacher's Profession, 1 cr
- Teaching and Learning Process: Planning and Evaluation, 2 cr
- Basic Teaching Practice, 2 cr
- Information Technology and Learning, 2 cr
- Communication Process, 1 cr
- Group Processes, 1 cr

Educational Research and Professional Use (8 cr)

- Introduction to Educational Research, 2 cr
- Introduction to Qualitative Research, 1 cr
- Qualitative Research in Practice, 3 cr

- Implementing Practice, 2 cr

Differentiated and Professional Studies (8 cr)

- Special Issues in Teaching and Learning, 2 cr
- Advance Teaching Practice, 4 cr
- Special Educational Issues in Teaching and Learning, 1 cr
- School Administration Foundations, 0.5 cr
- School acts and their implementation, 0.5 cr
- Education and Learning in Societal and Social Context, 1 cr

Advanced Educational Studies (40 cr)

- Seminar on Classics of Education, 2 cr

Or two of the following:

- Traditions in Education, 1 cr
- History of Education, 1 cr
- History of Science, 1 cr
- Education in Global Focus, 2 cr
- Educational organisations and their activities, 2 cr
- Orientation to Current Educational Problems and Research, 2 cr
- Literature of Advanced Studies, 4 cr out of the next:
 - Adult Education, 4 cr
 - Philosophy of Education, 4 cr
 - Psychology of Education, 4 cr
 - Teaching and Learning, 4 cr
 - Early Childhood and Primary Education, 4 cr
 - Sociology of Education, 4 cr
 - Education in Global Focus, 2 cr
 - Educational organisations and their activities, 2 cr
- Teaching Practice of Theme, 4 cr

Methodological Studies (4 cr)

- 4 cr out of the following:
 - Literature on Research Methods, 2 cr
 - Philosophy of Science, 2 cr
 - Qualitative Analyses and Interpretation, 2 cr
 - Quantitative Research Methods, 2 cr
 - Research Methods in Early Childhood Education, 2 cr
 - Introduction to Research on Using Computers in Teaching, 2 cr
 - Other Methodological Course, 2 cr

Thesis studies 20 cr

- Research Seminars 4 cr
- Master's Thesis, 16 cr

Minor Possible Studies in Education for Primary School Teacher Education at the University Of Joensuu

- Adult Education
- Special Education
- Multicultural Education
- Educational Administration
- Youth Study
- Others

Appendix III

General Studies for Primary School Teacher education at the University of Joensuu (13 cr)

- Orientation Course, 1 cr
- Speech Communication, 2 cr
- Scientific Swedish and Oral Skills, 2 cr
- Scientific English and Oral Skills, 2 cr
- Scientific Writing, 1 cr
- Introduction to the Foundations of Using Computers in Education, 3 cr
- Statistical Methods in Educational Sciences 2 cr