

# Mathematics Lessons from Finland and Sweden

*International comparisons highlight many differences and a few similarities among these two countries and the United States.*

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When responding to a question about why mathematics education is going so well in Finland, a Finn might just answer, “Tämä on Suomi!” (“This is Finland!”). When a Finnish upper-secondary mathematics teacher asked his quiet students, who were busy taking notes, “Hur många element i den aritmatiska talföljden  $\{6, 21, 36, 51, \dots\}$  är mindre än 10000?” at least half the students raised their hands with ideas. The question translates as “How many elements in this arithmetic sequence  $\{6, 21, 36, 51, \dots\}$  are less than 10,000?” (Some Finnish schools are Swedish speaking.)

This was one of many mathematics lessons I observed in Finland and Sweden during spring 2013 while on a sabbatical from teaching. Finland has become known worldwide for its steady improvements in its educational system over the past forty years and for high scores in reading, mathematics, and science according to the Organization for Economic Co-operation and Development's (OECD) Program for International Student Assessment (PISA) of fifteen-year-olds conducted every three years since 2000. What makes this



improvement noteworthy is that it has occurred without the extra hours of after-school and weekend classes that students attend in other high-performing countries such as Korea, Japan, Singapore, and China (Schachter 2011, p. 42). During my sabbatical, I visited six different schools (all grades 7 to 12) in the Helsinki area in Finland and sat in on two to three classes in each school. I was also able to visit with a mathematics education professor at the University of Helsinki.

I then crossed the Baltic Sea and made similar visits to three Swedish schools. Sweden's educational system is structured similarly to Finland's, yet its PISA results in mathematics have been closer to those of the United States, which have consistently been below the OECD average. One of the principals at Lindeskolan, a gymnasium (an upper-secondary school) in Lindesberg, Sweden, arranged a variety of experiences for me, including visiting advanced mathematics classes, a mathematics class for nursing students, and mathematics courses for immigrant students who need remedial work to prepare them for regular gymnasium programs. I also visited elementary schools in Lindesberg and Attarpsskolan, the latter a school for grades 1–9 near Jönköping.

## THE FINNISH AND SWEDISH SCHOOL SYSTEMS

Finland and Sweden both require nine years of comprehensive school. Children enter first grade at the age of seven (most children also attend a year of preschool at age six). Grades 1–6 are called elementary grades, and grades 7–9 are called lower-secondary grades. These two levels can be housed in separate schools or together. The lower-secondary grades are similar to the middle school grades in the United States and are taught by teachers who majored in the subject or subjects that they teach. Almost all students go on to more schooling after ninth grade because of the significant advantage for future employment.

Grades 10–12 in Finland consist of either general or vocational upper-secondary school. General

upper-secondary school is focused on academics, and most students go on to attend a university after finishing. To move on to a university in Finland, students must take the Matriculation Exam (ME) at the end of upper-secondary school.

Approximately 40 percent of Finnish students choose to attend vocational upper-secondary school. If a student chooses vocational school, he or she would typically continue on to a polytechnic school (which could be defined as a university of applied science). In Sweden, students can choose from upper-secondary schools all over the country, and some specialize more in certain fields of study. Vocational choices are also available at Swedish upper-secondary schools. In both countries, this level of school is called a gymnasium, and entrance at a particular school of choice is competitive, with acceptance based on grades from the first nine years.

## CLASSROOM OBSERVATIONS

So what did I observe? In many ways, mathematics classrooms in Finland and Sweden are very similar to what would be considered traditional classrooms in the United States. Classes began with checking homework and questions, followed by the teacher giving instruction in the new material, and ended with students working on their new assignment. But there were interesting differences as well, in mathematics and the education systems in general.

Finnish mathematics classrooms place a strong emphasis on problem solving. According to Perkilä and Lehtelä (2007, p. 83), "The Core Curriculum for the Finnish comprehensive school lays emphasis on some key concepts like everyday applications, problem solving, and the student's own thinking, experimental learning and the student's active role in acquiring information."

## Resources

Consistent with this emphasis, Finnish upper-secondary students are provided with a book of formulas and tables for mathematics, physics, and chemistry. Instead of testing for retrieval of facts, the focus is higher-level thinking. The students are allowed to use the reference book for all work, including the Matriculation Exam that upper-secondary school students take before graduation. Because of this common resource, the textbooks did seem to have a greater focus on problem solving and applications.

Mathematics textbooks in Finland have *all* the answers in the back of the book, so students can always check to see whether they have gotten the right answer. Sweden is similar, except that the books also contain some solutions in the back instead of just answers.

The National Curriculum in Finland provides guidance and necessary regulations for all schools,

but curriculum planning is done on the local level. It is the responsibility of teachers, principals, and municipalities to implement the core curriculum. Schools may choose from a variety of Finnish language mathematics texts. (One drawback for Swedish-speaking schools in Finland is that at this time there is only one choice in Swedish.)

I observed some unique differences in Swedish schools. Sweden has more immigrants than Finland (although immigration is growing in Finland) and works hard to help prepare them for success in Swedish schools. I observed and visited with a mathematics teacher who works exclusively with immigrants and who has developed many of her own materials to help her diverse group of students.

### Technology

Interactive whiteboards were in every Finnish classroom I visited, although I observed only one teacher taking advantage of this tool's capability (in an upper-secondary course in vectors). Everywhere else the board was used as a place to display the textbook or notes with a document camera. Finns acknowledge that there is some resistance to using technology in the classroom. Leino and Furinghetti (2007, p. 187) state, "Though the results of computer-based teaching are good in several experimental projects, relatively few changes can be found in Finnish mathematics teaching. Teachers say that they do not have enough time to learn and teach the use of the programs developed."

I found interactive whiteboards in only a few Swedish classrooms and was told that a decision was made not to invest in them at the upper-secondary school in Lindeskolan.

Texas Instruments calculators were used in classrooms, in particular the TI-Nspire CX CAS in the Finnish integral calculus course I visited. I observed students using laptop computers in only one class, an eighth-grade mathematics class. Students in groups of three or four used plastic clinometers to measure the height of a tree of their choice on the school grounds (Finland has an ample supply of tall pines!) and created a report with photographs and diagrams using school cameras and laptops. This teacher also teaches information and communications technology (ICT).

### Less Is More

Another phrase the Finns use is *vähemmän on enemmän* ("less is more"). Finnish students spend about 5500 hours in school between the ages of seven and fourteen, whereas estimates from some states in the United States are closer to 7500. In lower-secondary schools, on average, Finnish teachers teach about 600 hours annually, or about four

teaching lessons daily. According to the OECD, the average annual total teaching time in the United States in the lower-secondary grades is 1080 hours, which involves six or more daily lessons. So Finnish teachers have more time in their day to plan curriculum, assess learning, provide remedial help, and reflect on their teaching (Sahlberg 2011, pp. 63–64).

I found schools in both Finland and Sweden to have a more relaxed atmosphere than in the United States, with at least fifteen minutes between classes. I was always invited to join other teachers for a cup of coffee during this time. Most secondary classes met for seventy-five minutes, two or three times a week. I observed relatively small class sizes in both Finland and Sweden. The average class size in Finland was fifteen, and the largest class I observed was a Finnish advanced ninth-grade class with twenty-eight students.

### NATIONAL PRIORITIES

One of Finland's highest goals is equity in their schools and between schools. Finns call it *nosto monet* ("lifting the many"). They emphasize cooperation between schools and communities instead of competition. One result of this philosophy is very little tracking in mathematics classes. The only tracking that I observed was in the ninth grade, which is the final year of comprehensive school. Tracking can vary by school, however, so it is up to each school or community to decide whether to offer different levels during ninth grade.

If a school does offer tracking, students and families are free to decide what level of mathematics course they would like to take. The teachers or school staff can give advice, but they do not choose for the student. The reason that I was given for tracking in ninth grade is to help prepare students for the different paths they may take following comprehensive school. One criticism that I heard from Finnish mathematics teachers is that they feel that they do not always challenge the top students as well as they could because of their focus on the "many." One said that their top 10 percent of students may achieve less but their lower 10 percent of students achieve more. Results from the

**The educational system in Sweden is more accommodating to students' needs, whereas in Finland the priority seems to be that everyone should learn the subjects well.**

## Finland's high requirements for entering teacher education programs in universities mean that beginning teachers must earn a master's degree.

2013 International Mathematics Olympiad support this comment: Finland ranked sixty-seventh out of ninety-seven countries participating. The United States placed third, after China (first) and South Korea (second); Sweden was sixtieth (Dolinar 2013).

In Sweden, I was impressed with an emphasis on oral communication within the mathematics curriculum that I did not find in Finland. I sat in on a class in which the students were presenting their solution to a problem to a small group of classmates and their teacher, a required part of the evaluation of the students by the national curriculum. The upper-secondary schools in Sweden resemble a community college in many ways. The students have more breaks in their day, are free to come and go, and are already focused on a specific field of study. There are a wide variety of majors, such as nursing, electricity and energy, restaurants and food, natural science, humanities, and child care. Many courses at the beginning of each program are common courses (for example, English, history, religion, mathematics) so that students can switch from one major to another without too much difficulty.

Both a Finnish teacher who had visited schools in Sweden and Swedish teachers described the focus in Sweden as more accommodating to the students' needs, whereas in Finland the priority seemed to be that everyone should learn the subjects well.

### STUDENT PREPARATION

Hendrickson (2012, p. 488) highlighted the predominant use of formative assessment in Finland that aids student learning, in contrast to high-stakes standardized assessments in the United States that are used mainly to rank students, teachers, and schools.

The only standardized assessment in Finland, the Matriculation Examination (ME), is taken at the end of grade 12 in upper-secondary school and is a significant factor in acceptance to university programs. In contrast with the large number of multiple-choice type of questions on U.S. college entrance exams, the ME is essay based and open

ended. It has a significant effect on curriculum and instruction in the upper-secondary schools. Even with just this one standardized exam, I heard many Finnish teachers at that level say that they feel pressured and rushed as they try to prepare their students to pass the test. However, this pressure is not related to keeping their jobs or to the school's status or funding; rather, it is related to the hope that they have prepared their students adequately. As part of the ME, all students take an exam in their mother tongue and three subject exams chosen from their second domestic language (Finnish or Swedish), foreign languages, mathematics, and general studies (social and natural sciences).

Mathematics in Finnish upper-secondary schools is taught in seven-to-eight-week courses. The first of these is a course in functions. At the end, students are tested and then move on to the next course, polynomial functions. Course grades are numerical up to 10. Each course has its own small paperback textbook, which the students purchase. Teachers used the textbook extensively during classes, often displaying pages using a document camera. Students can choose between a six- or ten-course sequence in mathematics. If they are interested in opportunities in mathematics or science, they choose the ten-course sequence. The eight additional courses are geometry, analytic geometry, vectors, probability and statistics, differential calculus, root and logarithmic functions, trigonometric functions and sequences, and integral calculus. I observed five advanced ten-course sequence classes, and they were all quite small, having from six to ten students in each. The number of females in those classes was always less than half.

### TEACHER PREPARATION

A significant difference in Finland is that mathematics teachers in lower-secondary school (grades 7–9) and upper-secondary school (grades 10–12) must have a master's degree in mathematics, whereas preschool and elementary teachers must earn a master's degree in education. Finns are very proud of their research-based education system. All mathematics teachers whom I met have also studied a science topic such as physics or chemistry in their university work, and they teach both subjects. Teachers in other subjects, such as language, teach two languages, for example; they said it would be more difficult to find a job if you did not have the capability to teach more than one subject.

Teachers typically move with their students so that they have the same students for two to four years, enabling them to get to know one another well. This is especially true in the elementary and



lower-secondary grades. When I told a Finnish teacher of a ninth-grade mathematics class that American teachers quite often teach in just one subject area, such as mathematics, and might teach the same class to the same grade level year after year, she was surprised and thought such a schedule would not be very interesting. She had worked with her ninth graders for three years in both mathematics and chemistry.

Finland has high requirements for entering teacher education programs in universities and, as mentioned before, beginning teachers must earn a master's degree. Finnish teachers' salaries are better than in the United States. They make approximately 92 percent of what other college-educated workers make; in the United States, that figure is less than 60 percent (OECD 2011, p. 15).

Instead of test-based accountability, Finns use the words *responsibility* and *trust*. According to Sahlberg (2011, p. 125), their use of "sample-based testing, thematic assessments, reflective self-evaluations, and emphasis on creative learning have established a culture of mutual trust and respect within the Finnish education system. Before the end of upper-secondary school, or grade 12, no external high-stakes tests are given. There is no inspection of teachers, and only loose external standards steer the schools."

Cooperation among teachers, schools, and communities is encouraged rather than competition. As a result, teaching is a popular career in Finland, and more students apply than are accepted into the programs. In fact, only approximately the top 10 percent of applicants are chosen. Another difference in Finnish teacher preparation is the use of training schools for a portion of student teaching. These schools work closely with the university teacher education departments. The master teachers at the training schools are specially chosen and receive better pay than at other schools.

## ESTEEM FOR TEACHERS

Finally, teachers are held in high esteem in Finland. I found classrooms to be casual environments where students called teachers by their first name, but students were almost always respectful and on-task during instruction and independent work. This respect is a result of a number of factors. One teacher told me that during the period after World War II, three pillars of society rebuilt Finland: priests, doctors, and teachers. Society still views teachers and schools as having great value, although some teachers said they feel that this respect is eroding somewhat, especially in larger cities.

The greatest contrast to Finland that I found in Sweden was related to teacher respect, as described

by teachers, others I spoke with, and the Swedish press. Every teacher whom I met in Sweden felt that teachers are poorly respected and are blamed for many of Swedish society's problems. The atmosphere of the Swedish classrooms that I observed was different from that of the Finnish classrooms. I observed more challenge to teacher authority and more off-task student behavior, especially in lower-secondary classrooms. One Swedish teacher mentioned that he felt that earning respect is a part of Swedish culture; respect is not given just because of one's position.

Swedish teachers also said that government-mandated changes and reforms are too frequent and cause stress and extra work for teachers. In comparison with Finland, it is relatively easy to become a teacher in Sweden (a bachelor's degree is sufficient, as in the United States). In fact, Sweden currently has a shortage of teachers because today teaching is not considered an attractive occupation.

## CHANGES COMING

Just days before I left Sweden, I was excited to read an article in the DN.Debatt (debate) page of the Swedish newspaper *Dagens Nyheter* (*Today's News*) dated June 3, 2013. Ten changes that are proposed for Sweden were described by Jan Björklund, education minister; Eva-Lis Sirén, federal chairman of the Lärarförbundet (teachers' union); Bo Jansson, federal chairman of the Teachers' Federation; Anders Knappe, chairman of Sweden's municipalities and counties (SKL); and Mikaela Valtersson, chairman of the Independent Schools National Association. Many of these changes are patterned after Finnish ways (I have added "as in Finland" in those cases):

1. Raise teacher salaries (as in Finland).
2. Reduce administration requirements so that teachers are freed to concentrate on planning and implementing instruction.
3. Create an identification and eligibility certificate program, requiring proper training for all who teach a subject (this has already started and will be fully implemented by 2016; for example, it means that only elementary teachers with a specialty in math will be able to teach math).
4. Higher admission requirements will start in 2014 for basic eligibility to enter university education programs (as in Finland).
5. Institute an aptitude test for admission to teacher education, because good theoretical knowledge is not enough. Teachers must be good at communicating and interacting with others (as in Finland).



6. Didactics is an important part of teacher training. Master teachers should be involved in new teacher training (as in Finland).
7. Training schools should be established for all or part of their internship with qualified supervision provided (as in Finland).
8. Monitoring, evaluation, and assessment of student teachers should be improved so that they can grow in their teaching abilities during this time.
9. The first year of teaching is probationary and should be well developed with good mentor support (this has already started).
10. An educational research institute should be established; teaching in the classroom should be research-based to improve quality and outcomes of education in close cooperation with teachers and principals (as in Finland).

Many of the changes proposed in Sweden and the differences that I observed in Finland are not areas that individual teachers can change, but change on a larger scale is already beginning in the United States. Teacher preparation programs such as the University of Indianapolis, the University of South Dakota, Teachers College at Columbia University, and my own institution, Bethel University, have implemented or are developing full-year clinical practice for preservice teachers with specially trained clinical faculty and are raising the requirements for entrance to and completion of teacher preparation programs (Wilson 2013).

Some things that teachers can do are to strive to be worthy of respect by being experts in the mathematics we teach and in best teaching practices, to be willing to share our help and experience by mentoring both experienced teachers and new teachers. We can voice our opinions in favor of changes that will improve mathematics learning for as many students as possible here in the United States.

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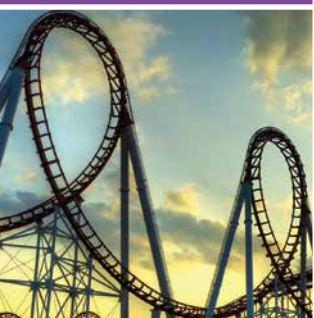
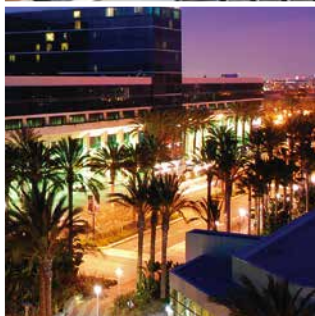
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