Societal Demands on the Profession of the Mathematics Teacher in Iceland in a Historical Context

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Abstract

The histories of official teacher education and school legislation in Iceland coincide with the history of ICMI. Iceland, a marginal country in Northern Europe, may be taken as an example when evolution of societal demands on the profession of the mathematics teacher is submitted to analysis and consideration. The following aspects will be considered:

- *Goals of mathematics teaching and the teachers' role as perceived by them and others;*
- *Mathematics education of teachers, teacher subcultures and didactical divide; and*
- *The present situation of education of mathematics teachers.*

The century will be divided into three periods; the early twentieth century, 1946 to the 1970s, and the present time. Iceland is sparsely populated (70,000 in 1900, 300,000 in 2006) and the number of mathematics teachers is low, so the history is traced by historical anecdotes.

Theoretical Background

Iceland belonged to the Danish realm until the 1940s, so Icelandic teacher education has its roots in Denmark. Niss and Jensen's (2002) description of the divide between the seminar tradition and university education in teacher education (pp. 81–82), and consequent teacher subcultures (pp. 160–162), applies to Iceland as well. Cooper (1985) and Gjone (1983) have also described a clash between teacher subcultures at the introduction of the "New Math" in the 1960s–1970s. Lately, Bergsten and Grevholm (2005) have written about the didactic divide in mathematics education; i.e., the lack of connection between different kinds of knowledge, such as disciplinary and pedagogical knowledge, and its relation to teacher education. Niss (1996) has analyzed the goals of mathematics teaching at various times in different societies and concluded that the focus has

varied between utility-oriented reasons, cultural maintenance of society, and equipping the individual to cope with life (p. 24). This paper will discuss goals observed in twentieth century Iceland, teacher subcultures, and the possibility of didactic divide, in the light of these papers.

The Early Twentieth Century

At the implementation of schools legislation in 1907, primary-level teachers were needed. The requirements for teachers were preferably that they completed some school education, but otherwise that they were intelligent people. Physically infirm people, not fit for farming work, were often appointed to teach. In 1903–1904, 415 persons worked as teachers. Of these, 134 had never been to school themselves, 24 had been to a teacher-training college, 99 were graduates from lower-secondary schools, 11 upper-secondary-school graduates and 18 tertiary-school graduates, mainly theologians. The remaining 129 included people with some vocational training (Finnbogason, 1905, p. 16). The 24 who had teacher training had either studied in Denmark or taken a one-year teacher training program in one of two lower-secondary schools in the country.

The teacher's task was to "hear" the pupils about their homework, one at a time, and the teacher was called a "hearer" (Halldórsson, 2001, pp. 64–65). The author of the legislation wrote:

> … The children learn the methods of calculation and use them without understanding at all … *why* one does this and not that. Such things destroy all understanding and independent thinking … Without doubt one could throw out many of the computation rules which still are found in some arithmetic textbooks, with a pompous look, as if they had stepped down from heaven. He who can think and use commonsensically the four main calculating operations, can for example solve any rule-of-three problem, even if he/she has neither heard of the rule of three, a front term, middle term or rear term nor the rules about their use (Finnbogason, 1903/1994, pp. 92–93).

This quotation indicates that the untrained teachers and/or authors of arithmetic textbooks took the syllabus of the upper school levels and transferred it to the primary level, expecting pupils to learn certain prescribed procedures.

The first Icelander with a university degree in mathematics, Dr. Ólafur Daníelsson, built up mathematics education of primary teachers when the Iceland Teacher Training College was founded in 1908. One of his students recounts:

> … I once stood at the board and was to compute a problem where a fraction was divided by another fraction. I solved the problem easily, as I had learnt by heart … the Doctor asked: Why is it correct to solve the problem this way? This I did not know and I do not remember if the other

> students in the class knew the answer either. … [His] teaching opened my eyes to how futile it is to teach to children … calculation methods without their understanding what they are doing (Þórleifsdóttir, 1958, p. 188).

Dr. Daníelsson called his students to the board, as tradition demanded, but he also awakened questions in their minds. In his textbooks he expressed his views on the goals of mathematics teaching and the capability of teachers to implement them:

> … Many learn the methods by heart without understanding their reasons; and more so as many of those who work at teaching may lack sufficient skills to explain the arithmetic down to its roots, without having for that any support from the textbooks (Daníelsson, 1906, pp. iii–iv).

> … The purpose of mathematics education in schools is completely hidden from some intellectuals; they think that the goal of geometry teaching is … to measure cabbage patches … No, the purpose … is to train the pupil in the precision of his thinking and at the same time his inventiveness, in which no other subject trains him to the same degree (1920, pp. iii–iv).

Dr. Daníelsson left teacher training for Reykjavík High School, Iceland's only school with an upper-secondary level, when a mathematics stream was established there in 1920. Some mathematical and pedagogical content knowledge for student teachers for the primary-school level was ensured in Dr. Daníelsson's time. However, many teachers were not familiar with the subject. For teachers at lower-secondary schools, study of theology was the accepted preparation. The teachers' task was, as before, to question the pupils, but many of them may not have had the capability to awaken their thinking, or even to perceive it as their task. Dr. Daníelsson continued to criticize mathematics teaching after he took charge of mathematics teaching at Reykjavík High School:

> … Pupils who have studied outside the schools [on their own or by private tuition] … have come up to … lower-secondary-school examination, prepared in algebra in such a way that they have only solved the exercises, but do not at all know the basis of the symbolic language, have sometimes had no tuition in it. This shows that some of those who work in teaching do not at all have a clear idea about the purpose of this subject, think that its importance is entailed in the pupils' becoming able to solve number puzzles … But mathematics is first and foremost an independent science, the most perfect existing … (Daníelsson, 1927, pp. 3–4).

In retrospect, one wonders how understanding of the purpose of mathematics could have been different in a semi-colonial country, where Dr. Daníelsson was the only mathematician, there were only a handful of engineers, and many of the primary teachers had had no schooling before their teacher training, or had not received teacher training at all.

Reconstruction of Secondary Education and "New Math"

School legislation established middle schools in 1946. Algebra and Euclidian geometry, which had hitherto been taught in the six-year high-school program, were now to be taught at middle schools all around the country. These topics were not even taught at the Teacher Training College. Only graduates of the upper-secondary-school mathematics stream were familiar with the topics. Few had studied mathematics at university; the discipline first became available in Iceland as part of engineering studies during World War II. The requirement for tenure at middle schools was 1–2 years' study at university, preferably in the teaching subject, and some general teacher training. The first middle-school mathematics teachers began their studies in, for example, law, medicine, theology, business administration or engineering.

In 1951 a B.A. program for lower-secondary-school mathematics teachers was established as part of the engineering program. Over a period of twenty years, 26 people graduated in mathematics and physics: 19 of them became teachers, 15 in middle schools. I interviewed three headmasters of three of those teachers, whose pupils had performed relatively better in mathematics than in other subjects at a national entrance examination into the upper-secondary level. The headmasters seemed not to have been aware of that their teachers had above-average mathematics education. One of them (November 2002) had noticed the good performance in mathematics in his school, but attributed it to the personal qualities of the teacher and did not connect it to his specialization. Another (October 2002) remarked that the general average had declined since the time when entrance to the examination was more restricted, and blamed lower performance in mathematics on the teacher, who had suffered from periodic mental illness. He had not noticed the relatively good performance in mathematics compared to other subjects and compared to other schools, presumably because the average results in mathematics overall in the country were below other subjects' averages. The third headmaster (December 2003) knew that his school's performance in mathematics was better than in the neighboring towns, but as his school exceeded them in most subjects, he said, he had not been aware that the mathematics performance of the pupils in his school was by far the best in the country (Bjarnadóttir, 2006, pp. 286–289). While the performance records pointed to a gap in mathematics education between university-educated teachers and others, even headmasters were wary about mathematics, and had more belief in teachers' personal qualities than in specialization in the subject.

A crucial moment in the history of mathematics education in Iceland was marked by influences from the OECD, advocating to policy-makers new concepts of the role of education, i.e., that it contributed substantially to economic and social progress (Efnahagsstofnunin, July 1965, p. 9). Another source of influence was a seminar held in 1961 in Royaumont, France, where the

OEEC (forerunner of the OECD) gathered mathematicians, mathematics educators and government officials in charge of mathematics education, to create new policy in mathematics education. The result was the "New Math"—school mathematics based on concepts from set theory and logic. No Icelander attended the seminar, but information soon filtered into the small community of mathematicians and to politicians and policy-makers, and led to increased attention to mathematics education. A survey made on behalf of the Ministry of Education showed that Icelandic teaching material was years behind that in the other Nordic countries (Björnsson, 1966); another survey, now lost, made by G. Arnlaugsson in 1965, also on behalf of the Ministry, indicated a lack of mathematical skills at compulsory level (Lárusson, interview 2002). Inadequate training of mathematics teachers was blamed. G. Arnlaugsson, a main proponent of the "New Math" movement and a former pupil of Daníelsson, wrote:

> Many teachers in the primary and middle schools have never in their studies met mathematical thinking … and there is a severe shortage of books in Icelandic that can improve this situation, so this is a serious problem. … The arithmetic and the mathematics must not be separate from other forms of logical thinking, they should precisely be the tool to train the child in logical thinking. If this is clear to the teacher, and he/she has an overview of the coherence of the topics of arithmetic that he/she is teaching, he/she could doubtless achieve a better result than many do now, even if there were few actual changes in the curriculum (Arnlaugsson, 1967, pp. 43–44).

The movement had great influence. The government supported wide-reaching reform of mathematics education, while teachers reconsidered their teaching methods. One of the five upper-secondary-school mathematics teachers who were educated before 1960 to master's level or more, said in an interview: "I stopped calling pupils up to the board and began lecturing (Jónsson, interview 2003)." A young, recently-graduated Ph.D., who had one year's experience of upper-secondary-school teaching, criticized the current situation in mathematics teaching:

> I think [it] is neglected … that the teacher gives a lecture … The purpose is not only to explain … but … to show the pupils how they should think. … To transform a practical problem into a mathematical problem always requires a minimum of mathematical thinking. … It must not be neglected to supply the pupil with some training in talking clearly and understandably about a mathematical subject, to express his/her thinking … (Elíasson, 1966, pp. 95–99).

Mathematicians Arnlaugsson and Elíasson wrote well-meaning guidelines to primary-school teachers, and Arnlaugsson steered great efforts in in-service courses for primary teachers for several years, until he was entrusted an even more important task, to build up a new modern upper-secondary school in

Reykjavík. But the writings of the two mathematicians reflected the divide in the 1960s between different teacher traditions, the university tradition and the seminar tradition, a divide that has not yet been completely bridged.

In a teachers' guide to a primary-level textbook series belonging to the "New Math" wave of the 1960s, written by a primary-school teacher, the teacher is encouraged to build his/her teaching on dialogues:

> The role of mathematics in developing language sense has increased greatly by the introduction of new attitudes to mathematics teaching … Teachers' dialogues with pupils about the topics will now become a much greater factor in the teaching than … hitherto … mathematics makes strong demands of clear and logical use of language, as logical thinking is the prime condition for mathematical thinking (Gíslason, 1967, p. 7).

The citations point to change in attitudes to the desirable way of teaching mathematics at all levels, away from questioning pupils or "hearing," towards lecturing or even dialogues, and training in mathematical thinking. However, the focus was more on the teacher than on the pupils.

Soon there was a backlash to the "New Math." The set-theoretical syllabus at primary level aroused debates and reactions. There was a clash between the perspectives of the two types of teachers, those trained at universities versus teacher-training colleges, where the former were the initiators and the latter were expected to implement the university version of mathematics. Similar problems occurred in other countries (Cooper, 1985, pp. 265–266, 282; Gjone, 1983, pp. i, 53, viii, 14–19; Høyrup, 1979, pp. 55–59). In many cases the teachers missed the point of the reform, and saw only yet another method, in addition to the old ones (Arnlaugsson, 1967, p. 43). The public saw cumbersome methods, wordy explanations and a decline in computation skills.

The introduction of "New Math" placed the two types of mathematics teachers at loggerheads, each interpreting and implementing school mathematics according to their own education and professional experience. Mathematicians emphasized the indirect purpose of training the mind, while most primary teachers were occupied with teaching methods and procedures, preparing pupils for their perceived future business in everyday life. The ultimate change was in content, rather than in pedagogy or new understanding of mathematics. Yet the arduous experience of "New Math" released teachers' initiative. Some primary-level teachers began to create new mathematics material which they felt they could teach, a task that no one had been considered able to take on.

Middle-school teachers were in between: They had some university training and more mathematical training than primary-level teachers and were better able to adapt to the new ideas. However, societal demands, as expressed by headmasters, focused on their general personal qualities and pedagogical intuition, rather than on their mathematical knowledge.

The Present Day

Teacher training was transferred to tertiary level in 1971. The requirements for middle-school teachers were no longer a B.A. or B.Sc. mathematics degree of 180 ECTS-equivalent credits in a sequential model of two teaching subjects, followed by a general 60-credit course in pedagogy and didactics, with upper-secondary-level mathematics stream as prerequisite. The 180 ECTS credit B.Ed. degree from the Iceland University of Education, with mathematics as an elective, required a total of 50 ECTS-equivalent credits, often in two subjects, mathematics didactic courses included, with no special mathematics prerequisites. In 2003–2004, 33% of mathematics teachers in grades 8–10 had a B.Ed. degree with mathematics as one of the electives, and 2% had a B.Sc. degree in mathematics. At the upper-secondary level, 46% had a B.Sc. degree or higher qualification in mathematics (Menntamálaráðuneytið, February 2005, p. 16).

The lack of mathematical training of teachers may be reflected in a relatively low number of pupils reaching the highest performance level in the PISA 2003 results. The scores of Icelandic pupils placed them in 10th to 14th place of 29 countries, similar to Danish and Czech pupils. The OECD average for level 6 of highest score was 4.0%. Of Icelandic pupils, 3.6% achieved level 6, compared to 4.1 % of Danish and 5.3% of Czech pupils. The three countries' performances at the lowest level were more similar, in the range 4.5–5.0%; Iceland's figure was 4.5%. Iceland's above-average performance was mainly based on a relatively large group at level 4, 23.2% (OECD, 2004).

Most University of Education students have a background in the social-studies stream at the upper-secondary level, where mathematics requirements have recently been reduced from 15 to 6 out of 140 credits (Menntamálaráðuneytið, 1999). Applications in 2005 reveal that 88% of upper-secondary-school graduates in 2003 or before had completed 12 mathematics credits or more, compared to 61% of graduates after 2003 (Applications, 2005). This may be counterbalanced by changes in requirements for mathematics education of student teachers, implemented in year 2007: For those preparing for upper-level primary teaching the requirement was raised from 8 ECTS credits to 20, and for lower-secondary level teaching from 50 to 80 ECTS credits. Other student teachers will be exempted from studying mathematics. In the first year of this program, only about 20% of the student cohort took the introductory mathematics course to both study lines.

Teachers at the present time are not only in a dilemma of adopting the mathematical content they are supposed to teach that is different from what they themselves learned in school. Working methods have also changed and the goals have shifted, while parents and the public use their own schooling as a reference. It is generally acknowledged that complicated computational skills are no longer needed. Yet parents still ask what procedure the teacher wants the child to learn,

while the teacher wants to encourage the children to find out their own procedures and promote their thinking skills (Riesto, interview 2007).

Summary and Conclusions

The history of the twentieth century in Iceland reveals an ongoing tension between university mathematicians (Daníelsson, Arnlaugsson, Elíasson), emphasizing training in mathematical thinking and cultural goals, and traditional utility-oriented demands to calculate accurately and quickly the types of problems pupils were expected to meet, but which may have been obsolete.

The teachers' task was to see that pupils obeyed the rules, to "hear" them. When it became a world-wide opinion that the frame of set-theory and logic would ease the study of mathematics, and that the purpose of the studies should move away from technicalities towards clarity in thinking, teachers at the compulsory-school level faced a dilemma. They tried to transfer their teaching techniques towards explaining and conducting dialogues. They observed a decline in the technical skills which were demanded by the parental sector of society, while a possible gain in thinking skills was hard to demonstrate. Teachers have been in this dilemma ever since.

In addition to differing education of teachers at upper and lower levels, explained by Niss and Jensen, and their different prerequisites for their task, the situation becomes more complex when it is taken into account that scarcely half of mathematics teachers, at either level, have any specialized training in the subject. Most Icelandic teachers have, however, a good general education, and social problems relating to immigrants and other minority groups are minimal, which may explain Iceland's above-average performance in international comparison studies. However, it seems reasonable to blame the relative lack of excellent performance on many teachers' lack of either disciplinary knowledge, or pedagogical knowledge, or both. A didactic divide as defined by Bergsten and Grevholm is thus not the main problem of Icelandic mathematics teachers, but their general lack of formal mathematics teacher education.

One may conjecture that the ability of Icelandic mathematics teachers to cope with their professional dilemma has yet to be improved, and may not improve until the situation of their education has changed considerably.

However, in a broader context, the history of the twentieth century in Iceland is that of a marginal country in Europe, which started the century as a colony, without legislation on officially supported primary education and teacher training and without a university. In light of that, remarkable development has taken place during the century, even if much work remains to be done.

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