

2-2014

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Recommended Citation

Gunnarsdóttir, Guðný Helga (2014) "Professional Development: Possibilities and restrictions for mathematics teachers in lower secondary school in Iceland," *The Mathematics Enthusiast*: Vol. 11 : No. 1 , Article 10.

Available at: <https://scholarworks.umt.edu/tme/vol11/iss1/10>

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Professional development: Possibilities and restrictions for mathematics teachers in lower secondary school in Iceland

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Abstract: *Mathematics teachers in many parts of the world have been facing many challenges in recent years. In Iceland teachers in lower secondary school have been implementing a new reform oriented curriculum. Many researchers claim teachers need considerable support if they are to meet the demands of the current reforms in mathematics education. This paper explores whether mathematics teachers at lower secondary level in Iceland are given good opportunities to develop professionally during the last five years and if not what can possibly be done to improve the situation. My conclusion is that the opportunities given are limited and do not meet features that characterize effective professional development. That specially applies for duration and coherence which are considered very important features along with, focus on content, active learning and collective participation. The organisation and funding of professional development in Iceland does not seem to allow for continuation and progression. One important step to deal with this problem would be to make it easier for teachers to attend courses at the universities and to arrange courses in such a way that teachers and student teachers can collaborate and form a learning community.*

Keywords: Mathematics Professional development; Icelandic teachers; Constraints; Organization of Professional development; Iceland

INTRODUCTION

According to the OECD –Teaching and Learning International Survey (TALIS) 22,4 % of teachers in lower secondary school in ICELAND took no part in professional development activities during the last 18 months and 48,5% took part in activities that lasted for less the 11 days. When asked what prevented them from more participation 47,2% of those who mention a special reason say that there was nothing on offer that suited them (Ólafsson & Björnsson, 2009). This inspired the present investigation on professional learning opportunities given to teachers in lower secondary school in Iceland since 2005. The year 2005 is chosen as a starting point due to the reason that from 1999-2005 the main focus of professional development programmes in mathematics was on teachers in grades 1-7. In that period mathematics teachers were implementing new teaching materials for the primary level.

Mathematics teachers in lower secondary school in Iceland have been facing many challenges in their work during the last 10 years. In February 1999 a new National Curriculum Guide in Mathematics was published by the Ministry of Education in Iceland. It is a reform oriented curriculum under the influence of NCTM standards (Bjarnadóttir, 2010). The main change in this new curriculum was that goals for mathematics were divided in to two categories, goals

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for mathematical processes and goals for content (Menntamálaráðuneytið, 1999). For the first time mathematical processes were given special attention in an Icelandic curriculum guide with an emphasis in the curriculum for equal attention to mathematical processes and mathematical content. The curriculum guide was revised in 2007 but only minor changes were made. A new reform oriented curriculum makes the teaching of mathematics more demanding as it calls for new competencies on behalf of the teachers and different instructional practices (Kilpatrick, 2004; Niss, 2004).

In Iceland the National Centre for Curriculum Material (NCEM)² provides schools with teaching materials aligned with National Curriculum Guidelines. Due to limited funds and lack of manpower (qualified authors) the publisher was not able to publish materials for all grade levels at the same time. The changes in the curriculum also called for progression and coherence in dealing with new content and instructional approaches and therefore it was considered best to start by renewing the teaching material for the lowest grades and then build on that. The publication of a new series of teaching materials in mathematics for grades 1-10 started in 1998 and it ended in 2008 (Gunnarsdóttir & Pálsdóttir, 2010).

Teachers were to implement the new curriculum in three years but little support was given to teachers to accomplish that task and new teaching materials for lower secondary school aligned with the new curriculum guide for grade 8-10 were published until 2005-2008.

The new teaching materials for lower secondary school, *Átta-10*, are very different from the Swedish textbook series, *Almenn stærðfræði* that had been in use since 1987 (Bjarnadóttir, 2010). According to Halldórsdóttir (2008) the Swedish materials build on teaching methods linked to behaviourism with emphasis on procedures, worked examples with lots of similar exercises to follow and self tests to assure that the students have mastered the required skills. Very little attention is paid to mathematical reasoning and communication (Valverde, Bianchi, Wolfe, Schmidt, & Houang, 2002). The teaching materials *Átta-10* build on different ideas about teaching and learning mathematics. In the new materials more emphasis is put on inquiry where students recognize problems, ask questions and look for solutions in cooperation with each other and the teacher. The students are encouraged to develop their own solution strategies, share and discuss them with others. The authors pay special attention to the mathematical processes and one of their main goals is to assist teachers to change their instructional practices towards a more reform oriented teaching) (Bjarnadóttir, 2010; Gunnarsdóttir & Pálsdóttir, 2010).

According to Cooney (2001) the current reforms in mathematics education are characterized by an instructional style in which more time is spent on conceptual understanding and problem solving. Reform teaching also involves more communication and creation of mathematical communities instead of telling and showing. It is therefore challenging for teachers to move from the traditional mode to the reform mode (Cooney, 2001). Many teachers in lower secondary school in Iceland have not specialized in mathematics and mathematics teaching and therefore it is important that they get some support when implementing a new reform oriented curriculum.

²(<http://www.nams.is/Languages/English-information/>)

In this paper I will explore which opportunities Icelandic teachers in lower secondary have had since 2005 to take part in formal and informal professional development. I use formal professional development as professional training organized by a recognized institution in the form of post graduate education, action research or professional development courses. Informal professional development refers to participation conferences, seminars, reading groups and short workshops and presentations.

I will compare this with what is known from research about effective professional development strategies and models for mathematics teachers. I will also explore how professional development in general is organized in Iceland and to which degree it supports or hinders good professional opportunities for mathematics teachers.

- Are mathematics teachers at lower secondary level in Iceland given opportunities to develop professionally and if not what can possibly be done to improve the situation?

WHAT IS EFFECTIVE PROFESSIONAL DEVELOPMENT?

During the last decade mathematics teachers in many countries have been struggling with implementing new reform oriented curricula. This has been challenging for the teachers. They have both had to deal with teaching new content areas and also to change their instructional styles to more process oriented styles with emphasis on inquiry, conceptual understanding and problem solving (Cooney, 2001). The aim of the reforms and of improved instruction is usually linked to increased student learning. It is also argued that teachers need considerable support if they are to meet the demands of current reform movements. Teacher opportunities to learn and develop their professional knowledge have therefore become central issues in the educational debate. Some scholars even claim that the education reform is often synonymous with teachers' professional development (Desimone, 2009; Sykes, 1996)

Teachers have many opportunities for professional learning both within formal professional development settings such as courses and in-service days and informal settings such as common planning and discussion of lessons, self reflection and reading of professional journals (Borko, 2004; Desimone, 2009; Wei, Darling-Hammond, Andree, Richardson, & Orphanos, 2009). Wei et al. (2009) "*conceptualize professional learning as a product of both externally-provided and job-embedded activities that increase teachers' knowledge and change their instructional practice in ways that support student learning. Thus, formal professional development represents a subset of the range of experiences that may result in professional learning.*" Easton (2008) argues that professional development will not always lead to professional learning and that it is not enough just to develop, educators need to learn and therefore she claims that professional development needs to be replaced with professional learning. Even though I agree with this view I will in this paper use the professional development for all opportunities available for teachers to increase their professional learning both the formal activities and the more informal settings as this is what is done in most literature on teachers' professional development.

Several researchers have tried to point out some principles for effective professional development by synthesizing results from various research and development projects (Borko, 2004; Desimone, 2009; Loucks-Horsley, Stiles, Mundry, Hewson, & Love, 2010; Wei, et al., 2009)

Wei et al. (2009) define effective professional development as development that leads to improved knowledge and instruction by the teachers and improved student learning. They draw on research from both the US and abroad that links student learning to teacher development. In their report *Professional Learning in the Learning Profession: A Status Report on Teacher Professional Development in the United States and a Abroad* Darling-Hammond, Wei and their colleagues put forward four main principles for designing professional learning:

- Professional development should be intensive, ongoing, and connected to practice.
- Professional development should focus on student learning and address the teaching of specific curriculum content.
- Professional development should align with school improvement priorities and goals.
- Professional development should build strong working relationships among teachers. (Darling-Hammond, Wei, Andree, Richardson, & Orphanos, 2009)

They also indicate that other factors like school-based coaching and mentoring and Induction programs for new teachers are important and likely to increase the effectiveness of teachers. They also point out that intensive professional development rooted in practice is most likely to change teaching practices and lead to increased student learning.

Loucks-Horsley and her colleagues have for more than a decade worked on professional development and in the third edition of their book *Designing Professional Development for Teachers of Science and Mathematics* published in 2010 they review new developments in the knowledge base for professional development and use it to enrich the basic principles of effective professional development they presented in their earlier work.

According to Loucks-Horsley et al. (2010) the principles that are present in quality professional development experiences are:

- Effective professional development is designed to address students learning goals and needs.
- Effective professional development experiences are driven by a well-defined image of effective classroom learning and teaching
- Effective professional development experiences provide opportunities for teachers to build their content and pedagogical content knowledge and skills and examine and reflect on practice critically
- Effective professional experiences are research based and engage teachers as adult learners in the learning approaches they will use with their students.

- Effective professional development provides opportunities for teachers to work with colleagues and other experts in learning communities to continually enhance their practice.
- Effective professional experiences support teachers to deepen their professional expertise throughout their career and serve in leadership roles
- Effective professional development experiences provide links to other parts of the education system
- Effective professional development experiences are continuously evaluated to ensure a positive impact on teacher effectiveness, student learning and the school community (Loucks-Horsley, et al., 2010).

It is clear that these principles are very broadly focused and there is an emphasis on linking professional development to teaching practice and student learning. It is also evident that the establishment of professional learning communities is seen as important. Professional learning communities seem to play an important role in supporting teachers in continuously improving their teaching and sustaining their professional learning. (Fernandez, 2002; Loucks-Horsley, et al., 2010) Lesson study is referred to as an example of a professional development strategy that has many of the aspects that characterize effective professional development. Lesson study enhances teachers' knowledge and quality teaching, it develops leadership capacity and the building professional learning communities (Loucks-Horsley, et al., 2010).

According to Desimone(2009) there is a consensus among researchers on the main critical features of professional development that can be linked with changes in teachers practice and knowledge and to some degree in student learning. She points out five main features. They are focus on content, active learning, coherence, duration and collective participation. According to Desimone there is strong evidence that focus on content and how students learn that content in professional development can be linked to teacher development and to some extent to student learning. Active learning where teachers engage in various activities like observations, reviewing of student work and discussions is also an important feature. Teachers also need to feel there is coherence between their beliefs and knowledge and their experiences in professional development and between reforms and policies at all levels. Collective participation and duration are also very important features. Teachers need time to work with, reflect on and try out new ideas and they need to do this in a learning community with others dealing with the same issues. For Desimone these features (*focus on content, active learning, coherence, duration and collective participation*) become the basis of a framework for studying the effectiveness of professional development. She considers the content focus on teacher learning among the most influential ones based on many different kinds of studies(Desimone, 2009).

The critical features Desimone points out seem to capture the core in principles for effective professional development both Darling- Hammond et al. (2009) and Loucks-Horsley et al. (2010) present.

They also have much in common with what Borko, Koellner, Jacobs & Seago (2011) claim is the shared view of many teacher educators on professional development. According to this view professional development for teachers should be a collective endeavour, it should be about the work of teaching and the learning opportunities should be situated in the teachers practice.

Gunnarsdóttir (2002) studied a professional development program in Iceland. It was a two year program for teachers in grade 1-10 in one school district with 7 schools and 240 teachers. The study was based on interviews with 21 teachers who took part in the program. She identified four critical features that aided to the success of the program. Firstly the project encouraged collaboration and provided opportunities for collaboration between teachers. Secondly, courses were organized in a way that it gave teachers opportunities to develop their understanding of mathematics and mathematics teaching and learning. In addition it also provided them with a safe environment to implement ideas in their practice and reflect on their experiences to further develop their own mathematical understanding as well as understanding of their students' thinking. Thirdly, there was an organizational support, the school district and principals all invested in the program and provided teachers with support to participate in the program. And finally, the program spanned over two years (Gunnarsdóttir, 2002). These four features have much in common with the critical features of professional development suggested by Desimone (2009). In my analysis of the professional learning opportunities given to Icelandic teachers in grades 8-10 from 2005-2011 I will use the features from Desimone.

THE ORGANISATION AND FUNDING OF TEACHERS PROFESSIONAL DEVELOPMENT IN ICELAND

Iceland is a small country with 319 090³ inhabitants. To put things into perspective it is necessary to provide some basic information about the Icelandic school system and its financial background. Local authorities are responsible for the operation of a 10 year compulsory school for children from the age of 6 – 16. In 2010 the total number of students in compulsory schools was 42929, the number of teaching positions was 4791 and the total cost for running the compulsory schools was 56 billion IKR (487 million USD)(*Skólaskýrsla 2010*). In 2011 the Icelandic state allocates 199.9 million IKR to compulsory schools and 69,3 million of those funds go to continuous education and school development. The state also gives 423,2 million to publication of educational materials for compulsory schools("Fjárlög fyrir árið 2011,").

According to the salary agreements between the teachers union and local authorities teachers in compulsory school should spend up to 150/126/102 hours a year (depending on age and holiday rights) for professional development and special preparations for their teaching outside their traditional yearly working schedule. The professional development should be under the supervision of the principal and in accordance with the schools professional

³ October 1st 2011 (<http://www.statice.is/Statistics/Population>)

development plan. The principal can *ask* individual teachers or groups of teachers to attend specific a professional development activity. Teacher's professional development activities can be divided into two parts, activities that are considered necessary for the school and activities that the teacher finds important for him/herself.

Individual schools and local authorities are responsible for funding teachers' professional development but they can seek support from different channels. In the following an overview is given of the funds that support teacher's professional development, their policy and how they are financed.

Continuous Education Fund

The Ministry of Education allocates a certain amount each year to a Continuous Education Fund a managed by The Association of Local Authorities in Iceland. In 2011 the fund got 22.7 milljon IKR (197000 USD) which is a similar amount as in previous years. Those who want to provide professional development opportunities for teachers, school councillors and head masters in the compulsory school can apply for money to the fund for instance local school authorities, schools, teacher education institutions, associations and firms (Fjárlög fyrir árið 2011)

School development fund

Each year the Ministry of Education allocates money to a school development fund. The aim of the fund is to support development and innovation in pre schools, compulsory schools and upper secondary schools. In 2011 the fund got 46,6 milljons IKR (405000 USD). The Ministry sets some priorities for applicants each year like assessment, democracy, creative thinking, literacy and connections between school levels. Mathematics teaching and learning has not been among the priorities during the last five years and only two projects with focus on mathematics have been supported during that period. Only headmasters of schools can hand in an application on behalf of schools, groups of teachers or individual teachers. Others have to be in a partnership with schools The fund is managed by the Research and Development Centre at the Universty of Akureyri.

Project and education fund managed by the Teachers Association (KÍ)

The main goal of the fund is to support the professional development of teachers, student councillors and head masters in compulsory school. Employers pay monthly 1,72% of regular salaries into the fund. Members of the Teachers Association and the Headmasters Association can apply for the money in the fund.

They can apply for:

- Support to attend courses, conferences and to go on study trips
- Support for (formal) further education at university level
- Group support to go on study trips to schools and institutions
- Support to local and special organisations of teachers to for instance to pay for professional lectures at annual local teacher conferences in the autumn

- Support to individual teachers or groups of teachers for research and development projects
- Paid study leaves up till 12 months

In 2010 the fund spent 403 milljon IKR on these purposes. 31% went to paid study leaves for teachers or head masters, 25 % to research, development projects, professional courses and study trips (1/3 went to support teachers who are attending post graduate education) and 44% to support to teachers to attend courses, conferences and study trips (Verkefna- og námsstyrkjasóður FG og SÍ: Ársskýrsla 2010).

Most local school authorities have also allocated some funds for professional development to the schools. In 2004 it was estimated that this added up to 83 milljon IKR (Mennta- og menningarmálaráðuneytið, 2010) During the current financial crisis this post that has been cut down drastically by many local authorities. In the City of Reykjavík the schools with 1480 teachers got 24 milljon IKR for this purpose in 2008 but in 2010 and 2011 they got nothing. In Fjarðarbyggð a municipality with around 90 teachers the schools get 1,8 million (20 000 per teacher) for professional development in 2011 which is 2/3 of what they got in 2008. In Hafnarfjörður the schools (both pre and compulsory schools with around 1000 employees) get 5-6 million for this purpose which is a similar amount as in previous years.

PROFESSIONAL DEVELOPMENT OPPORTUNITIES FOR MATHEMATICS TEACHERS IN LOWER SECONDARY SCHOOL IN 2005-2011.

In this section I provide an overview of formal professional development opportunities given to teachers in grades 8 – 10 since 2005. It is based on data from the University of Iceland, School of Education, The Continuing Education section at the University of Akureyri, Reykjavík University, reports from funds awarding money to professional development, information from Flötur the Association of Mathematics Teachers, the city of Reykjavík and other available sources. It cannot be guaranteed that this is a complete overview but it should give a good picture of the situation.

University of Iceland

A special institution *Símenntun, Ranssóknir Ráðgjöf (SRR) (Lifelong learning, Research, Consultancy)* has been operating within the School of Education offering service like professional development to schools. The institution is partly self-financed. The institution offers course at set dates at the university campus, assists individual schools and local authorities in planning and applying for funding for professional development activities and operates a webpage with description of various professional development activities that members of faculty have to offer and that can be tailor-made to the needs of schools, local school authorities or others. Courses offered by SRR do not give the teachers any university credit points but they give the teachers an opportunity to fulfil some of the yearly requirements for professional development.

Courses at university campus.

At University of Iceland campus in Reykjavík a course called *Teenagers and mathematics* for teachers in lower secondary school was on offer. The focus of this course was to introduce to

the teachers new teaching materials Átta-10 (the first book in the series was published in 2005) based on the 1999 reform oriented National Curriculum Guidelines and to encourage teachers to develop their own teaching plans with the aid of the new materials but taking into account their own students needs and situations. Emphasis was on instructional approaches like inquiry, discussions, problem solving and hands on activities as well as the teaching of certain content like algebra, geometry and fractions. Different assessment methods were also introduced and teachers were given time to discuss and work on their teaching plans together. The first course was a 15 hour course in the spring 2005 spread over four afternoons. The course was attended by 20 teachers from different parts of the country.

Upon request the course was repeated in the autumn. Here the teachers who were implementing the new materials were encouraged to try out ideas presented in the course with their students and report back on their experiences during the next session. This course was attended by 15 teachers and most of them came from area surrounding Reykjavík.

A third course of the same structure was on offer during the autumn of 2007 but was not carried out as intended because of very few applicants. The few applicants were invited to take part in informal meetings (free of charge) with the instructors. This resulted in 6 meetings were 5-7 teachers met with the instructors and got some input and shared their experiences and ideas.

Instructors at these courses were teacher educators at the university who also were the authors of the new teaching materials for grades 8-10. The participants pay a fee of approximately 150 dollars for a 12 – 16 hour course.

In June 2007 SRR offered a workshop on the teaching and learning of algebra for teachers in grades 6 -10. The focus of the workshop was how to develop numeracy and symbol sense and it was given by Abraham Arcavi, professor at the *Weizmann Institute of Science in Israel*.

In the spring 2010 The University of Iceland and SRR arranged a course in the use and development of teaching materials for the mathematics software GeoGebra. The course was on offer for both university students and practicing teachers and gave the students 5 ECTS⁴ credits. The course was held on seven Saturdays from January to April. It was attended by 15 practicing teachers.

Tailor made courses for local authorities

Teacher educators at the University of Iceland have developed several courses for mathematics teachers in lower secondary school in cooperation with SRR and local school authorities. They assist in writing course descriptions for applications to the Continuous Education based on request from the local authorities. The requests from the local authorities are usually rather general and they are mainly about supporting the teachers in implementing the curriculum and the new teaching materials.

⁴ A full academic year of studies is 60 ECTS-credits (European Credit Transfer and Accumulation System).

The timeframe for these courses is usually 1-2 days carried out in August before the start of the school year. The teachers come from different schools in the area. The focus of these courses has been similar to the course given at the university campus. Courses of this type were offered by the local school authorities in Reykjanesbær (2006), Suðurland (2006), Akranes (2006), North East Iceland (2006, 2008), Borgarbyggð (2007), Mosfellsbær (2007), Höfn (2007), Snæfellsbær (2009). A majority of math teachers in these areas have attended the courses. The courses have been paid by the local authorities and in most cases they have been financed with money coming from the Continuous Education Fund.

University of Akureyri, Continuing Education

The University of Akureyri has a Continuing Education section. They offered courses for mathematics teachers in lower secondary school in the area in 2005 and 2006. They were developed and carried out by the teacher educators from the University of Iceland and had a similar focus and content.

Reykjavík University

In 2008 Reykjavík University offered two courses that they called workshops for mathematics teachers. The objective of these courses was to give a theory-based opportunity for professional development for Icelandic mathematics teachers. They were 15 – 20 hours workshops carried out over a period of 4 days. The first workshop was in August before the start of the school year and the second one after school hours and during a weekend in the end of September. The focus of the workshops was effective teaching strategies based on research on classroom practice. The instructor was guest lecturer in mathematics education at Reykjavík University who in his Ph. D. Study had compared classroom practices in Finnish and Icelandic classroom. These courses were free of charge for the teachers.

Other professional activities for mathematics teachers organized by local school authorities or others.

In 2010 the *The Division for Primary and Junior Education* in The City of Reykjavík held a 5 hour workshop for mathematics teachers. The focus of the workshop was the 2007 National Curriculum Guide in Mathematics. Instructors were teacher educator from the University of Iceland and an editor of the 1999 National Curriculum Guidelines in Mathematics and a teacher in a compulsory school in Reykjavík with M. Ed. in mathematics education. The workshop was funded by the Continuous Education Fund.

In 2007 local school authorities in Selfoss and Akranes offered a course on teaching number fluency and arithmetic with direct instruction and precision teaching. It was a one day course given by a teacher and a behaviour analyst. Both courses were funded by the Continuous Education Fund.

Flötur: The association of mathematics teachers in Iceland has been arranging a two days seminar for teachers at all school levels every autumn. At these seminars well known international experts in mathematics education have been giving lectures and workshops for teachers as well as local experts and practicing teachers. In the last five years Richard Noss, John Mason, and Jo Boaler have been among the invited experts at these seminars. The seminars have been attended by 50-100 teachers at all grade levels and it is often the same

teachers that come year after year. The number attending the seminars has been declining. The conferences have been financed by contributions from continuous education funds for compulsory and secondary school teachers and by fees (150 dollars) paid by the participants. Most teachers get refunds from their schools or their professional development fund but some pay themselves.

In association with the NORsMA (The Nordic Research network on Special Needs Education in Mathematics) conference in 2009 a pre conference workshop for teachers was given⁵. It was a 4 hour workshop where both Icelandic teachers and researchers and international researchers worked with teachers on representations, outdoor teaching of mathematics, mathematics in games and plays and cognitive variability (60 teachers from all grade levels attended the workshops. The workshop was free of charge due to Nordic funding of the conference.

Included in this overview are only activities that last for at least 4 hours. Teachers have had various opportunities to attend lectures or workshops of a shorter duration held at seminars arranged by teachers associations, universities, The NCEM, schools and others.

Qualification programs

As mentioned above teachers do not get any university credit points for attending professional development courses offered to them by professional development providers like the universities or local school authorities. In order to gain credits teachers have to attend post graduation programs like a Masters program or special qualification programs set up by the authorities in order to raise the level of specialized knowledge of qualified teachers. Both Reykjavík University and the University of Iceland have offered Masters programs in mathematics education and the Ministry of Education has supported special qualification programs for mathematics teachers during the period under investigation here.

Master programs in Mathematics Education

The University of Iceland offers a master's program in mathematics education. The programme is organized as a combination of campus and distance education program with 5-6 days of instruction at campus for each 10 ECTS course. Practicing teachers who have specialized in mathematics during their initial teacher training can enrol in the studies either as full time or part time students. Obligatory courses in the studies are courses on theories and research in mathematics education, on curriculum and competence development in mathematics and one course in pure mathematics where students can choose a course on real numbers and real functions or a course on algebra and linear algebra. Among other elective courses is a course on the history of mathematics and courses on research methods and educational theories. On average 5-8 teachers have enrolled in the programme each year since its start in 2004 and 8 students have finished a Masters degree in mathematics education.

Reykjavík University offered a master's program in mathematics and didactics from 2005-2008. The last enrolments were in 2008. It was organized as a two year program with

⁵ (http://stofnanir.hi.is/norsma/pre_conference_workshops)

instruction in the afternoon enabling practicing teachers and others to take part in the program. Requirement for enrolment was a Bachelor's degree in any subject. The studies consisted of courses in both mathematics and didactics with an emphasis on a problem based approach. In total 32 graduated from the programme but it can be estimated that around 50 students in total took some of the courses in the programme. Those who graduated were not all certified to teach in schools (compulsory or upper secondary) due to different backgrounds.

Specialisation in Mathematics and mathematics education for practicing teachers

In 2005 the Ministry of Education initiated a qualification programme for teachers in lower secondary school who had been teaching mathematics for some years without having specialized in mathematics during their initial teacher education. They were offered to take courses in mathematics and mathematics education at a Bachelor level at Iceland University of Education (Now University of Iceland, School of Education) in total 50 ECTS during a period of two years. The courses were similar to courses given to regular student teachers who specialized in mathematics teaching and organized as a mixture of campus and distance education so that they could be attended by practicing teachers. Around 50 teachers enrolled into the programme but many dropped out due to a heavy workload and only 8 finished the studies in 2007. Five of the others took several courses and one finished in 2008. This programme was free of charge for the teachers and those who lived more than 200 km from the University campus could get the travel costs refunded. The Ministry gave a special support to the University for these studies.

In 2006 on the occasion of the publication of new Mathematics Curriculum Guidelines another programme for the same group was supported by the Ministry of Education. Based on the experiences from the programme in 2005 the teachers who applied took part in a 6 ECTS preparatory course. It started with a 12 hour preparatory workshop where the new Mathematics Curriculum Guidelines were presented and their implications for teaching in compulsory school. The teachers got an opportunity to discuss which support they felt they needed for implementing the curriculum. The workshop was followed up by a course in mathematics and mathematics education which was based on an analysis of the teachers needs. After the preparatory course the teachers could attend courses of their own choice at all universities offering courses in mathematics and mathematics education for a period of three years in order to attain 30 ECTS credits in total. This programme was also free of charge for the teachers and those who lived more than 100 km from the University campus got some travel support. In mathematics 6 teachers have finished the 30 ECTS credits and 34 have finished the preparatory course and several have also taken some courses at the universities mostly at the University of Iceland, School of Education.

Analysis and discussion

The previous section provides an overview of formal professional activities offered to teachers in lower secondary school teachers from 2005 – 2010. In this section they are analyzed according the framework suggested by Desimone (2009) for studying the effectiveness of professional development. According to her there are five critical features

that characterize effective professional development. These features are focus on content, active learning, coherence, duration and collective participation.

It is evident that most of the professional development opportunities described above have a strong content focus both mathematical knowledge and pedagogical content knowledge. Many of them are directly linked to implementation of new curriculum and the aim is to support the teachers in this task. Requests from local authorities reflect both a need for support in teaching new content and in using different instructional strategies.

The national curriculum guide for mathematics and the new teaching materials for lower secondary school put an emphasis on active learning on behalf of the pupils and investigative approaches and mathematical processes are at the core (Bjarnadóttir, 2010; Gunnarsdóttir & Pálsdóttir, 2010). If teachers are to engage their students in active learning they have to experience that kind of learning themselves. This has been an important feature of many of the professional development courses given (and in mathematics teacher education in general in Iceland).

When it comes to the features duration and coherence the situation is different. All specially designed professional development courses are very limited in scope. The courses have typically been one or two day workshops and only given to each group of teachers once. This is due to limited funding. The money allocated to professional development activities by the funds supporting these activities is limited and funds are only given for one year at a time. Courses are also usually held just before the start of the school year or during teacher preparation days at the beginning of the school year. Since most courses involve teachers from more than one school it is difficult to find time for teachers to meet for a course during the school year. It is evident from research on professional development that courses of this structure and length are not likely to have much impact on teachers practice. They can serve some purposes like providing information about new trends and materials but they are not likely to have any impact on teaching practice (Loucks-Horsley, et al., 2010). There are indications that to make an impact on teaching practice and student learning professional development opportunities must to be of much longer duration (30 – 100 hours) and be spread over a longer period of time for instance a whole school year (Darling-Hammond, et al., 2009; Loucks-Horsley, et al., 2010; Wei, et al., 2009).

For teachers taking part in qualification programs like master programs or other programs aimed at raising the level of specialized knowledge on mathematics education among qualified teachers the situation is different. Such programs should at least in principle secure duration and coherence since they are planed as a sequence of courses over a longer period of time (2-3 years).

Many of the specially designed professional development courses encourage collective participation. Teachers from different schools in a municipality or area meet for the course and even though they are of short duration they give teachers opportunities to collaborate within schools and across schools. This is especially important since many of the schools in

Iceland are small (62 out of 152 schools with lower secondary level have less than 50 students). It is therefore not possible to create professional learning communities for mathematics teachers inside the schools. The teachers need to find ways to collaborate across schools and professional development courses and workshops can create such opportunities even though they are of short duration.

Experiences from different structures of qualification programs also indicate the importance of collaboration and creation of learning communities among the students taking part in these programmes. At Reykjavík University the Masters program was organized in short modules concentrating on one subject at a time requiring students to meet and work together four afternoons during the week. At the University of Iceland students at Masters level take 1-3 courses (10 ECTS each) per semester and the studies are a mixture of distance and on campus courses where students meet at campus for 5 days for each course. Most of the students are part time students perhaps only attending one or two courses each semester so they do not form a group taking courses together. Reykjavík University graduated 32 students with a Masters degree from 2005-2010 and the University of Iceland 8 students while the number of students enrolled in the programmes is estimated to be similar. Even though the two programmes are different in many respects it is worth considering the different structure of the programmes and the different possibilities for collaborations created within them and its impact on the number graduated.

This also applies for the difference between the programmes giving practicing teachers opportunities to increase their knowledge in mathematics and mathematics education. On one hand the program starting in 2005 were the teachers were treated like one group throughout the program and given courses similar to courses given to regular students but organized to meet the needs of practicing teachers and the program starting in 2006 were only the first course was specially designed. In spite of big dropout the first program resulted in 13 teachers finishing 30 – 50 ECTS during a period of three years but the other resulted in 6 teachers finishing 30 ECTS during a period of four years. The group from 2005 formed a strong group and they created smaller groups on regional basis that met and worked together. Many of these teachers are now enrolled in post graduate studies or are leading development projects in mathematics in their schools. In the second program the teachers, after finishing the preparatory course, selected different courses on individual basis and took part in the regular distance program with teacher students and had limited opportunities to collaborate with other practising teachers. The fact that the teachers who started their studies in 2005 (those who did not drop out) were treated like group throughout their studies seems to have had a positive effect on their professional development.

Conclusion

When analysing the professional development opportunities mathematics teachers in lower secondary schools have had during the last 5-6 years it seems clear that the short duration of courses and lack of coherence are the main problems. The funding system does not allow for long time planning and progression of courses. The limited number of mathematics teachers

in lower secondary schools (an estimated number is (Ólafsson & Björnsson, 2009) 300) also sets some restrictions to what can be on offer.

There is a growing concern about the organisation of teachers' professional development opportunities among teachers, teachers unions, the education authorities and the professional development providers. Teachers do not gain anything in the form of higher salary by participating in professional development unless they finish a master's degree. Before 2001 teachers got credit for taking part in formal professional development which resulted in higher salaries when they reached certain amount of credit points. Today they have to fulfil some requirements for PD but often they feel there is little on offer or at times that do not fit their working schedule (Ólafsson & Björnsson, 2009).

In 2009 the Ministry of Education appointed a committee to make some suggestions about how to reorganize the continuous education of teachers at all school levels. The members of the committee came from the Ministry, the teachers unions, the Association of Local Authorities and the Universities that educate teachers.

The committee voiced some concerns about the organisation of professional development and whether this met the needs of the school system. One special concern was the provision of content specific professional development. Here the committee felt there was a need for further work on analyzing the needs of teachers and on making a joint policy. Another suggestion was to make all offers for professional development more accessible for teachers by creating a web page with information about what is on offer at all school levels as well as information about prices and funding. The committee also pointed out the need to make it easier for practicing teachers to attend courses at the universities. Teachers who want to take courses at a university usually have to apply formally to a study programme and pay registration fees each year (Mennta- og menningarmálaráðuneytið, 2010). The universities have a variety of courses that could be of interest to practicing teachers and often they are both on offer as campus programs and as distance education. It has to be made easier for teachers to attend such courses.

Opening up more opportunities for teachers to attend courses at the universities seems to be an important step to make it possible for teachers to attend professional of longer duration and to secure more depth and progression in their studies. But this is not likely to meet fully their needs to collaborate with other practicing teachers and create learning communities. It is therefore also important that the universities design courses that meet the needs of teachers to collaborate with other teachers and study together. Such courses should also give the teachers ECTS credit points they can use if they choose to enter a formal study program later and to document their formal professional development. The universities can also offer other types of courses, workshops and seminars and support developmental work but such activities are less likely to meet all the criteria for effective professional development unless they are combined with other strategies for professional development. But they can serve other purposes like informing on new educational materials and developments, contribute to the shearing of ideas and establish contacts between schools and individuals.

Even though the universities can provide valuable opportunities for professional development it is also important that schools individually or in cooperation with others can design their own professional development projects based on their needs. To make such activities more effective the funding organisms must allow for more long time planning and allocate more money to each project on the expense of number of projects funded each year. This is especially important during the present economical situation where the schools themselves can add very little to the money provided by the funds. In 2011 the Continuous education fund gave the compulsory schools 2424000 IKR to 162 projects during the school year 2011-2012 which means on average 150000 per project (1300 US Dollars). The tuition cost for 1 hour professional development course can be estimated to be 100 – 150 US dollars so what can be done for this amount is very limited.

Another important issue is the time teachers have to participate in professional development. Regardless of which approach you choose for instance to attend courses at universities or take part in activities organized at local level teachers need time to engage in the activities. Making time for professional development is according to Loucks-Horsley et al. (2010) one of the critical issues in designing professional development but not only making time is important but also how it is used. More money allocated to each project might make it easier for schools to free some time for professional development. It should also be possible to find time for professional development within the yearly working schedule of teachers. According to information from OECD Icelandic teachers spend 34% of their yearly working hours (1800) on their teaching in class (OECD, 2011). With good planning, some flexibility and perhaps fewer projects to engage in at a time it finding time should not be a big problem.

Even though there though there are challenges in organizing good professional development opportunities for mathematics teachers in Iceland it should be possible to make the offers more effective without making any fundamental changes to the system at hand. The main challenge in mathematics education is to provide content specific opportunities that are of considerable duration and allow for progression and coherence. With some flexibility and collaboration between all parts this should be possible.

References

- Bjarnadóttir, K. (2010). The history of public education in mathematics in Iceland and its relations to secondary education. In B. Sriraman, C. Bergsten, S. Goodchild, G. Pálsdóttir, B. Dahl & L. Haapasalo (Eds.), *The First Nordic Sourcebook on Nordic Research in Mathematics Education* (pp. 447-465). Charlotte, NC: Information Age Publishing.
- Borko, H. (2004). Professional Development and Teacher Learning: Mapping the Terrain. *Educational Researcher*, 33(8), 3.
- Borko, H., Koellner, K., Jacobs, J., & Seago, N. (2011). Using video representations of teaching in practice-based professional development programs. *ZDM*, 43(1), 175-187.
- Cooney, T. J. (2001). Considering the Paradoxes, Perils, and Purposes of Conceptualizing Teacher Development. In F.-L. Lin & T. J. Cooney (Eds.), *Making Sense of Mathematics Teacher Education* (pp. 9-31). Dordrecht: Kluwer Academic Publishers.
- Darling-Hammond, L., Wei, R. C., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession: A status report on teacher*

- development in the United States and abroad.* Dallas, TX: National Staff Development Council.
- Desimone, L. M. (2009). Improving impact studies of teachers professional development: Toward better conceptualizations and measures. *Educational Researcher*, 38(3), 181-199.
- Easton, L. (2008). From Professional Development To Professional Learning. *Phi Delta Kappan*, 89(10), 755.
- Fernandez, C. (2002). Learning from Japanese Approaches to Professional Development: The Case of Lesson Study. *Journal of Teacher Education*, 53(5), 393-405.
- Fjárlög fyrir árið 2011.
- Gunnarsdóttir, G. H. (2002). Stærðfræðiátakið í Hafnarfirði: Áhrif á starfsþróun kennara [The mathematics project in Hafnarfjörður: Its influence on teachers' professional development. Iceland University of Education.
- Gunnarsdóttir, G. H., & Pálsdóttir, G. (2010). The implementation of the intended curriculum in teaching materials; Authors perspective. In B. Sriraman, C. Bergsten, S. Goodchild, G. Pálsdóttir, B. Dahl & L. Haapasalo (Eds.), *The First Nordic Sourcebook on Nordic Research in Mathematics Education* (pp. 539-549). Charlotte, NC: Information Age Publishing.
- Halldórsdóttir, R. (2008). *Stærðfræði fyrir 8. bekk, námsbækur - námskrá.* A master's thesis. Reykjavík: University of Iceland, School of Education.
- Kilpatrick, J. (2004). Promoting the Proficiency of U.S. Mathematics Teachers Through Centers for Learning and Teaching. In R. Stässer, G. Brandell, B. Grevholm & O. Helenius (Eds.), *Educating for the future. Proceedings of an International Symposium on Mathematics Teacher Education.* Göteborg: The Royal Swedish Academy of Sciences
- Loucks-Horsley, S., Stiles, K. E., Mundry, S., Hewson, P. W., & Love, N. (2010). *Designing Professional Development for Teachers of Science and Mathematics* (3rd ed.). Thousand Oaks, CA: Corwin.
- Menntamálaráðuneytið. (1999). *Aðalnámskrá grunnskóla, stærðfræði.* Reykjavík: Menntamálaráðuneytið.
- Niss, M. (2004). The Danish "KOM" project and possible consequences for teacher education. In R. Stässer, G. Brandell, B. Grevholm & O. Helenius (Eds.), *Educating for the Future. Proceedings of an International Symposium on Mathematics Teacher Education.* Göteborg: The Royal Swedish Academy of Sciences.
- OECD. (2011). *Education at a glance 2011: OECD indicators:* OECD Publishing.
- Ólafsson, R. F., & Björnsson, J. K. (2009). *TALIS - Staða og viðhorf kennara: Teaching and Learning International Study: Alþjóðleg samanburðarrannsókn unnin í samvinnu við OECD fyrir menntamálaráðuneytið.* Reykjavík: Námsmatsstofnun.
- Skólaskýrsla 2010.* Reykjavík: Samband Íslenskra Sveitarfélaga.
- Sykes, G. (1996). Reform of and as professional development. *Phi Delta Kappan*, 77(7), 465-489.
- Valverde, G. A., Bianchi, L. J., Wolfe, R. G., Schmidt, W. H., & Houang, R. T. (2002). *According to the Book. Using TIMSS to investigate the translation of policy into practice through the world of textbooks.* Dordrecht: Kluwer Academic Publishers.
- Wei, R. C., Darling-Hammond, L., Andree, A., Richardson, N., & Orphanos, S. (2009). *Professional learning in the learning profession. A status report on teacher professional development in the United States and abroad. Technical report.* Dallas, TX: National Staff Development Council.

