ANNALES OF THE POLISH MATHEMATICAL SOCIETY
5TH SERIES: DIDACTICA MATHEMATICAE 30 (2007)

DOCTORAL THESES

Réka Szász
Debrecen University

Facilitating Differentiation in Mathematics in Hungarian Secondary Education[1]

1 Introduction

There is a diversity of students in every classroom, and the process of adapting to their individual needs is called differentiation. Due to increasing differences among students, the greater emphasis on equal opportunities, and the introduction of the two-level secondary final examination it is becoming a more and more acute need. However, teachers in Hungary face both professional and practical difficulties with applying the method. The aim of my thesis is to find ways of facilitating differentiation in Hungarian secondary mathematics education.

I use the acronyms CLFE and ELFE for the Core and Extended Level of Final Examinations, respectively.

2 Differentiated teaching – literature review

2.1 The diversity of students

Results of several surveys, such as the international PISA, and the national MONITOR showed that variation in mathematical attainment has increased in Hungary. The following factors underlie mathematics achievment:

[1] Advisors: Dr. Czeglédy István, Dr. Nemetz Tibor, 2007.

Mathematical competence
Mathematical ability
Cognitive stage
Prior mathematical learning
Communication skills
Attitude towards mathematics
Motivation
Self-confidence
Way of learning
Learning style
Study skills
General factors
Gender
Social background
Special needs

2.2 Differentiation as an answer to diversity

The usual solution to student differences is ability grouping and keeping with the middle. Research has shown that neither are effective, and an alternative is differentiated teaching.

2.3 Ways of differentiation

Differentiation is 'the process of identifying, with each learner, the most effective strategies for achieving agreed targets'. We can realize it in the following aspects.

Content
Task
Pace of learning
Outcome
Way of learning
Lesson form
Teaching method
Use of aids
Checking and assessment

Besides, there are many tools that facilitate differentiation, such as an appropriate **curriculum** and **textbook**, the availability of **assistant teachers**, the use of **computers.** Some teaching methods such as **lesson forms** with

pairwork and groupwork, the use of **real-life context** are also beneficial, and also methods which are appropriate for a **diversity of students**.

2.4 Differentiated curriculum models

I present two differentiated curriculum models. The **Enrichment Model** consists of the same *core material* to be completed by all students, with *enrichment material* for students who master the core faster. In the **Differentiated Model** each topic starts with a *core activity* to be completed by all students, ensued by *follow-up activities* of different levels.

3 Teachers in Hungary and differentiation

This chapter presents findings of a survey on differentiation I carried out with Hungarian mathematics teachers. The aim was to find out how acute the problem of diversity is, how teachers handle it, and what kind of help they need most.

3.1 Diversity of students

Teachers perceive their classes to be quite heterogeneous, but they mostly focus on achievement, ability and attitude of their students, not considering other important ones as communication skills, self-confidence, and study skills.

3.2 Extent and ways of differentiation

I found that two thirds of teachers differentiate in some way, mostly by pace and task, and somewhat by teaching methods. However, most of them do not differentiate the curriculum, even in groups where students prepare for different levels of the final examination. I also found that many of them favour weaker students with the material and teaching methods. Aids as assistant teachers and computers are scarcely available for them. And finally, they teach frontally in more than half of lesson time, which is a lesson form totally inappropriate for differentiation.

3.3 Conclusion: What kind of help is needed?

Teachers would need theoretical help in form of pre- and in-service teacher training, and also practical support. The rest of my thesis suggests ways of providing teachers with practical help through curricula (Chapter 4), textbooks (Chapter 5), and assistants (Chapter 6).

4 Devising differentiated curricula conforming to the National Curriculum

This chapter analyses the present practice of applying the NAT (Hungarian National Curriculum) with regards to differentiation, then suggests a method for preparing these in a way that supports differentiation.

4.1 The National Curriculum and differentiation

Secondary school curricula are based on the **NAT** and **final examination requirements**. The next level of the system is the **frame curriculum** (*kerettanterv*), which schools can use as a help to write their **local curriculum** (*helyi tanterv*). Finally, teachers prepare **syllabi** for each of their groups, which conform to the local curriculum and give a lesson by lesson plan for the material to be taught. This way the NAT is adapted to the supposed average need of each group, and it also allows teachers to differentiate, but it does not give them any guidance on how to. My suggestion for giving such guidance is the following.

4.2 The Differentiated Curriculum System

I suggest a model of frame curricula, local curricula and syllabi, the **Differentiated Curriculum System**, which follows the *Enrichment Model*. As curriculum determines the content of the lesson only, this system supports differentiation by content.

4.2.1 The Enrichment Curriculum Model revisited

4.2.2 Base frame curriculum

The Differentiated Curriculum System has a **base frame curriculum**, which sets the minimum requirements of the NAT and CLFE topics as the core material, and offers a very wide range of enrichment material including ELFE topics. In other words, it contains the minimum amount of core, and an almost maximum amount of enrichment material. .

4.2.3 Frame and local curricula

Frame and **local curricula** are designed with the help of the base frame curriculum, including all its core material in the core, and selecting further core and some enrichment material from its enrichmnt topics. Frame curricula try

to cover the usual types of secondary mathematics groups. There are two four-year-long, and two six-year-long sets of curricula depending on the number of mathematics lessons the class has, each branching into two in the last two years for basic and specialty (*fakultációs*) classes.

4.2.4 The syllabus

Finally, teachers write a differentiated **syllabus** based on the local curriculum, but using the freedom it allows. For each lesson, the syllabus includes differentiation and enrichment of the material involved.

4.2.5 Applying the syllabus

I tried the syllabus designed in the above way, and I found that I could use it effectively for differentiation.

5 Textbooks in Hungary and differentiation

According to section 3.2, the most commonly used series of textbooks are *Sokszínũ Matematika* (Colourful Mathematics) by Kosztolányi, Kovács, Pintér, Urbán and Vincze from Mozaik, and *Matematika* (Mathematics) by Hajnal, Számadó and Békéssy from Nemzeti Tankönyvkiadó (NTK). There is a third series of special interest to the topic, *Matematika* (Mathematics) by Czeglédy, Hajdu, Hajdu, Kovács and Róka from Mũszaki Könyvkiadó (MK), which was written with the primary aim of creating a differentiated textbook. This chapter analyses the three series in order to give guidelines to textbooks writers on how to support differentiation in their books, and to teachers on how to use a textbook for differentiation. Besides analysing the texts themselves, I use student and teacher feedback on the books.

5.1 About the textbooks

5.2 Differentiated curriculum

5.2.1 The curriculum of the books

All three books use a differentiated curriculum, as they have core and enrichment topics, and they include problems of different difficulty. I suggest, however, that fewer topics should be included in the core, and more in the enrichment material for a greater flexibility of curriculum, and differentiated syllabi should be provided.

5.3 Ways of differentiation

Due to the differentiated curriculum, the books support differentiation by **outcome**, specifically by *task* and *pace of learning*. But number of *open ended questions*, to help differentiation by *outcome*, could be increased. All three textbooks help differentiation by **way of learning** thanks to the great number of worked examples and visual illustrations. An answer book is partly published for all three series, which supports differentiation by **checking answers**. Differentiation by **assessment** is supported by the MK team through a test booklet following the framework of the two-level final examination. Tasks with **computers** are basically not available for the textbooks, but they have examples of **real-life context**.

5.4 Serving a diversity of students

The books **serve a diversity of students** in various ways. Differences in *competence* are bridged by moving from the concrete towards the abstract, and also by revision sections. A good *attitude towards mathematics* is reached by motivating content, context, and illustrations. Concerning *way of learning*, I found examples of making connections within and outside mathematics and of teaching study skills, but I suggested that communication activities should also be included.

6 Assistant teachers in Hungary

In this chapter I describe a project where my aim is to have an assistant teacher in the classroom to help in differentiation.

6.1 Bilateral motivation

The main idea is to use pre-service teachers as assistants, as they equally benefit from the extra teaching experience they get.

6.2 School-university partnerships

The view that school experience should have a greater role in initial teacher training has initiated an endeavour to establish and strengthen partnerships between teacher training institutions and schools.

6.3 The teacher trainee as an assistant teacher

I have worked out the idea of the teacher trainee working as an assistant teacher on two levels: the ideal realization, and the level, on which it can be easily introduced at present.

6.3.1 The ideal model

In the ideal model, teacher trainees have a school practicum every second semester, starting from the first year of their training. In the school component of the course, trainees work as assistant teachers, and help out in different lessons and school activities, gradually increasing the amount of teaching and responsibility. They have pre- and post-lesson discussions with school teachers. In the university component the trainees have a seminar where they get theoretical training and a connected focus of observation from the professor, and they also have post-lesson discussions with the professor and peers. Assessment is based on the evaluation of the school teacher and on a report written by the trainee.

6.3.2 Pilot project

The aim of the present project is to set up circumstances as close as possible to the model described above, within the boundaries of the present training system. I started from the mandatory school experience of third year mathematics teacher trainees, and cooperated with the professor responsible for the course. In the transformed model the main change is that the trainee assists in the lessons instead of observing them, there is more emphasis on pre- and post-lesson discussions, and the trainee has regular consultations with the professor.

The project has been running for two years, with one trainee each year. Evaluation was based on feedback from the trainee, students, the professor, and myself. Both years, the students and I thought that the trainee was great help, and the trainees found the experiment beneficial. However, we found that we cannot oblige the trainees to meet the professor regularly until this is part of the curriculum. The first step towards this would be running an optional discussion course (with university credit) linked to the school experiment.

7 Summary

On the whole, I found that the system and practice of Hungarian secondary mathematics education is very effective in some aspects of differentiation, but

has shortcomings in others. Besides appropriate pre- and in-service teacher training, improvement can be made by offering practical help to teachers, such as a differentiated curriculum, a textbook that supports differentiation, and assistant teachers in the classroom.

Publications in refereed periodicals:

C z e g l é d y, I. and S z á s z, R.: 2005, The mathematics textbook as an aid to differentiation, *Teaching Mathematics and Computer Science*, **3/1**, 35-53.

S z á s z, R.: 2005, The mathematics trainee as an assistant teacher, *Teaching Mathematics and Computer Science,* **3/2**, 295-306.

S z á s z, R.: Mathematics teachers and differentiation – results of a survey concerning Hungarian secondary schools, *Proceedings of the 3^{rd} Conference of PhD Students in Mathematics Education (III. Felvidéki Matematikai Szakmódszertani Doktorandusz Konferencia),* accepted.

S z á s z, R.: Methods of Hungarian mathematics teachers to handle student differences, *Annales Mathematicae et Informaticae*, accepted.

Presentations:

Differentiated Teaching of Mathematics in the Secondary School, Alfréd Rényi Institute of Mathematics, Hungarian Academy of Sciences, Sessions on the Day of Science, Budapest, November 3, 2003.

Differentiated Teaching in the secondary Mathematics Classroom, László Rátz Conference of Mathematics Teachers (Matematikatanárok Rátz László Vándorgyũése), Nyíregyháza, July 9, 2004.

Maths in English Lite: Teaching Mathematics partly in English in an average school, Tamás Varga Days (Varga Tamás Módszertani Napok), November 12, 2005.

Mathematics Teachers and Differentiation, 3^{rd} Conference of PhD Students in Mathematics Education (III. Felvidéki Matematikai Szakmódszertani Doktorandusz Konferencia), Komarno, December 10, 2005.