Lifelong Learning Programme

Multiculturalism, Migration, Mathematics Education and Language
Project Number: 526333-LLP-1-2012-1-IT-COMENIUS-CMP

WHO DID WHAT IN MATHEMATICS IN MY COUNTRY?

by Andreas Ulovec*

INTRODUCTION

The idea of this unit is to use history of mathematics to demonstrate that many cultures have contributed to the development of mathematics as a science. Students, in small group work, find out about mathematics that has been developed in their country of origin or in their culture, and/or about famous mathematicians of their culture. These small groups then design posters with their results and present them in class. By this, the students will recognize that the contributions of each individual in their classroom, particularly those from students with a minority or migrant background, can offer new perspectives and insights, and are therefore to be welcomed and indeed encouraged. It will show that mathematics is a truly intercultural subject, and that today's mathematics would not exist without the inputs from many cultures. It will also allow students with a minority or migrant background to actively present a small part of their cultures' achievements, and by that to see their background as an asset, and not a burden or an obstacle. To the teacher, the work and the findings of the students can be used as examples for the interculturality of mathematics in later lessons and with other students, even without repeating the unit itself. It may also lead to the teachers' increasing awareness and sensitivity with respect to intercultural aspects.

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Main piloting

by Andreas Ulovec and Therese Tomiska

The proposal

This unit consists of 5 lessons, with 45-50 minutes per lesson.

In *Lesson 1*, the teacher gives a short general introduction into the history of mathematics (short overview of timeline, including times of development of most important concepts [of school mathematics' topics], and most important names, e.g. Pythagoras, Newton, Leibniz …, depending on which names the students are familiar with. It is important to choose names from different cultural backgrounds).

After this, students are divided in small groups (approx. 3 students each). If the classroom situation allows this, each group should have at least 1 student with a migrant background. Ideally, these students should be of a different migrant background for each group. Here, it is not important whether the students have a recent migrant background, just that there is some connection to another culture and/or country. Should this not be possible, each group is either picking a country, or is assigned a country by the teacher. In any case, each group is linked to a specific country at the end of this part.

The students receive the following instructions: "Find either one mathematician of the country, or a topic of mathematics that has been invented, developed or is otherwise closely connected with the country. Then design a poster presenting the most important information about this person or topic, and prepare a short (5 min) presentation about it. The poster should also contain basic information about the country."

In *Lessons 2-3*, the actual group work, eventually outside of the classroom (library, computer room), takes place. Students are to commence their search, by using the school library, internet resources, or other materials that might be provided by the teacher. Teacher is to check on the group work, particularly seeing to it that the timeframe is kept.

In *Lesson 4*, students design the poster and prepare the presentation. The teacher is to provide guidance, particularly as to poster content, which information is provided there, and how it is presented.

In *Lesson 5*, students show their posters to the whole class and give a 5 minute presentation about their most important findings. Each presentation ends with a short question-and-answer session. The eventual assessment of this activity should not concentrate about the perfect design of the poster, or the quality of the presentation, or the choice of the mathematician or topic. It should provide feedback about the readiness of the students to approach mathematics as an international subject, to see the importance of achievements made by other cultures, and – particularly for the

majority students – to accept the input of fellow students who come from a minority background.

The piloting

General Information

The unit was piloted in grade 7 (age of students: 16-17) of a secondary school in a suburb of Vienna. The teacher is a female mathematics teacher with 5 years teaching experience. She occasionally talks about history of mathematics in her regular teaching activities. The piloting took place during regular lessons, and 10 students participated. The unit was video recorded, and feedback has been collected after the unit by an interview with the teacher and a video analysis by the unit author.

Classroom piloting

The teacher introduced the topic and gave the instructions as stated in the proposal, i.e. the students are to form small groups of 2-3 students, then find a mathematician from one of the students' countries and prepare a poster and a short presentation about this mathematician." The whole introduction as described in the proposal was not done in a separate lesson, since students were already aware of mathematics' timelines and important historical figures in mathematics.

The students chose the following mathematicians: Olga Taussky-Todd (then Moravia, today Czech Republic), Gottfried Leibniz (Germany), Archimedes von Syrakus (then Greece, today Italy), Kurt Goedel (Austria, later USA).

Lessons 2-3 took place outside the classroom. The students had one week time to prepare the presentations. They mainly used internet resources, and also the local library. It was not necessary for the teacher to provide additional materials. Since this was a major exam time, the teacher and students decided not to realize the posters, but have an oral presentation of the chosen mathematicians' biographies. In any case, one of the groups decided to make a poster anyway.

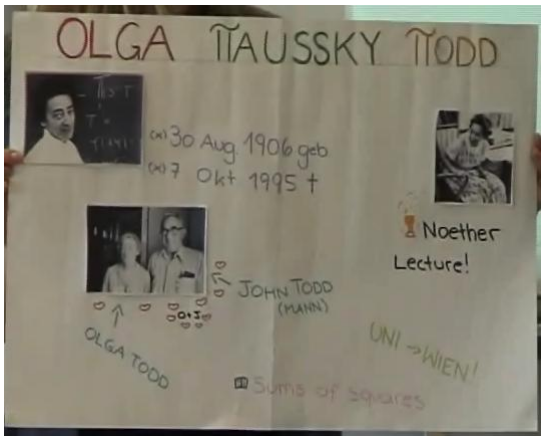

Photo 1. Poster of Olga Taussky-Todd (note the π symbols in place of the T's)

The general absence of posters made Lesson 4 unnecessary, so the piloting continued in the classroom with Lesson 5.In this lesson, the students were called to choose one representative of their group and conduct the presentations.

The first group (2 students) decided to have a presentation with both students participating. One student was responsible for the poster presentation, the other orally presented the biography of Olga Taussky-Todd, using a note sheet.

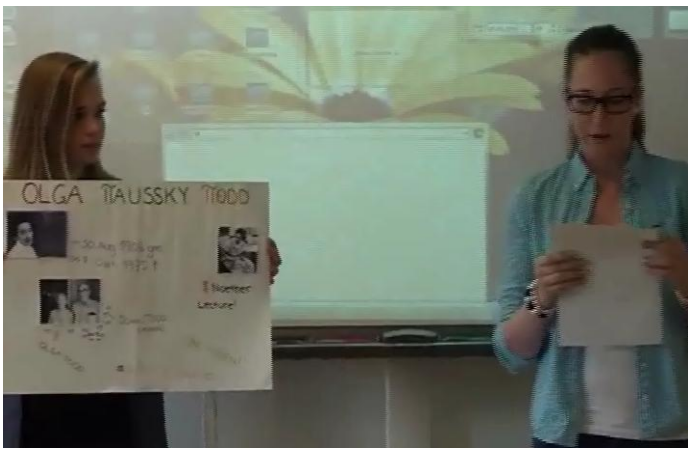

Photo 2. Presentation of group1 regarding Olga Taussky-Todd

This choice of mathematician was interesting for several reasons. First, it was the only female mathematician chosen. Second, it was an almost contemporary mathematician who is fairly unknown to the public. And third, it was a mathematician who had a migration background herself.

The second group consisted of three students. They chose one representative to present the biography of Gottfried Leibniz. The student used note cards and displayed a classic drawing of Leibniz with a projector.

Photo 3. Presentation of group 2 regarding Gottfried Leibniz

This group noted that it was difficult for them to find a topic of mathematics that Leibniz developed and that could be explained with a certain degree of understanding to school students.

Group 3 also consisted of three students who chose the classic Greek mathematician Archimedes. They used the same approach as group 2, i.e. an oral presentation with note sheets and a projection of an image of Archimedes.

Photo 4. Presentation of group 3 regarding Archimedes of Syracuse

This group particularly noted the interdisciplinary nature of mathematics and physics, and also the fact that research about people from a more distant past is fairly difficult, as facts are hard to find and also hard to discern from legend.

The fourth group, two students, chose the Austrian-American mathematician Kurt Goedel. They were the only group using a PowerPoint-Presentation.

Photo 5. Presentation of group 4 regarding Kurt Goedel

The group also mentioned the forced emigration of Goedel, as well as his acceptance and scientific establishment in the USA.

Since no questions came after the end of the first presentation, the teacher decided to have the question-and-answer session for all groups together at the end of the lesson. Students particularly were interested in the story of Goedels forced emigration due to his Jewish heritage, as well as why Olga Taussky-Todd decided to emigrate. The teacher used this opportunity to speak about reasons of migration in general, as well as the importance of the acceptance that both Taussky-Todd and Goedel experienced in their country of immigration.

Interview with the teacher

The day after the teaching unit was piloted, an interview was conducted with the piloting teacher. This interview took place in the conference room of the piloting school and lasted approximately 30 minutes. The teacher appreciated the possibility

that this unit gave her with respect to thematising the issues of interculturality and students with migration background. She mentioned that as far as general society aspects are concerned, in the past she already used several opportunities that arose from teaching to talk about gender issues and gender stereotypes, but until this unit she never saw a good opportunity to discuss cultural, migration and minority issues. From her observations of the small group work, she saw that the students with migrant background were very eager to contribute the story of "their" mathematician (particularly those who chose Taussky-Todd and Leibniz), and this input was very well received by the other group members. She also mentioned that the group who decided to present an Austrian mathematician (without having an idea of who this might be) had a hard time to find an "appropriate" figure, mainly because at the beginning they restricted their search to the Classic and Middle Age time periods, as well as to the most "famous" names. Only after the teacher told them that it was not necessary for the chosen person to be famous in the sense that everyone knows their name, and that they might as well look to more modern times, were they able to proceed. In one of this groups' discussions (after choosing Goedel) they also wondered why – despite Goedels contribution to mathematics being one of the most fundamental – practically no one knows about him. The teacher also mentioned the fact that in this particular class she never had any issues with or about students with a migrant background, and that they are very well integrated into the class community.

Second piloting

by Barbro Grevholm[**], Kari-Sofie Holvik and Camilla Norman Justnes

The piloting

General Information

The teaching unit was piloted by two female mathematics teachers with several years teaching experience working in one lower secondary school in Kristiansand and one lower secondary school in Trondheim, respectively. The Norwegian project team sent the material to the teachers approximately 3 months before the planned piloting activity. The teachers had 5th (11-12) and 8th (14-15) grade available for piloting. After a meeting with the project team, the first teacher chose to conduct the piloting during a regular mathematics classes (40 minutes) in the 8th grade. Several students in the class are migrant students. The second teacher carried out the unit in a 5th grade class. After the piloting, the teachers produced written reports and evaluations of their work. These reports are the basis for the summary here.

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Classroom piloting

From Karuss school in Kristiansand

The teacher conducted session 1 in the form of a short introduction into the history of mathematics (supported by a PowerPoint presentation) and especially about Fibonacci.

After this the students were organized in groups of three, where at least one student had a background from another country, for example from Turkey, Eritrea, India, The Czech Republic, Vietnam, former Yugoslavia and China. They were given the task to find out something about the history of mathematics from these countries.

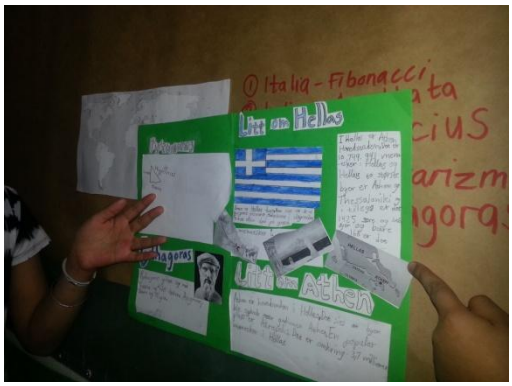
In session 2 the students continued to work in order to find material on the internet. For several of the groups it was difficult to find important mathematicians or important history of mathematics for the intended country. In such cases they were given permission to search relevant material also from neighboring countries.

In session three the students selected the most important parts of their findings and prepared a presentation for which they wrote down main points on posters.

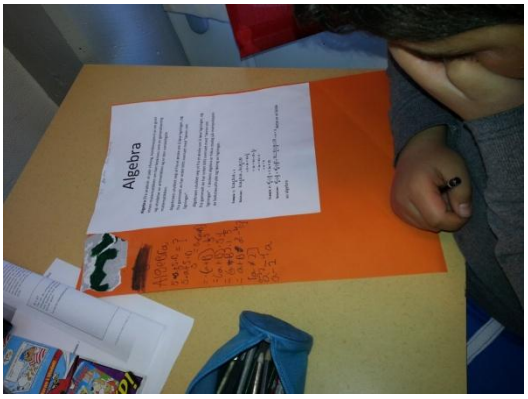
In session four the groups performed their presentations in front of the class.

From Saupstad school in Trondheim

The teachers used a week for this teaching unit and both the lessons in mathematics and Norwegian. Session 1 started with showing the TV-programme Siffer, which is available on the web-site of nrk (main Norwegian TV-channel). In addition the teachers ordered books from the main library in the city. They received about 20 books, mainly intended for adults. The pupils worked in the ordinary classroom and computers were available on rolling tables. The pupils worked in pairs, where one pupil had a foreign background. As only few countries were represented among the pupils, like Turkey (40% of pupils) and Ghana, the teachers wrote the names of some other countries on papers and the pupils could draw another country from them. The sessions otherwise followed the outline in the teaching unit. The instructions in the unit for the pupils were handed out in written form to the pupils also given to parents attached to the weekly programme. After the pupils had chosen subject or mathematician, teachers helped them with copies of relevant parts from the books. They also used the web-site www.matematikk.org (otherwise pupils have a tendency to use Wikipedia as main source). Presentations were made in the form of exposition of posters. See photos below. A timeline was used and along it different texts were attached. The teachers prepared a historical presentation and it was exposed in connection to the pupils' presentation of their findings.



The poster presenting Greece and Pythagoras' theorem



Pupils preparing the text about Algebra

Pupils working with the findings about Pascal

Abacus/kuleramMe!

Kuleramme kalles abacus på matematikkspråket.
Kulerammen er et hjelpemiddel for å regne.
For lenge siden brukte man kulerammen.
Den vi bruker i dag er kinesisk og er fra år 200.
Slik kan en kuleramme se ut

What Sofie wrote on the poster about the abacus

The timeline and reports from many different cultures.

Written reports and evaluations from the teachers

Karuss school: The pupils seemed very interested and motivated in the beginning. It was fun to do something else in the mathematics lesson and interesting to find out something about your home countries. The pupils lost courage a little when they did not find anything, but were engaged again when they were allowed to include other countries. The teacher often had to assist in understanding what they read about, for example analytical mathematics, vector calculations and so on. It was great that one group of pupils explained Pythagoras' theorem for right angled triangles, which we will study later this year.

The pupils found most interesting and important discoveries in Greece, Italy, Egypt and China. The teacher writes: "I had thought that pupils earlier thought that the discoveries of mathematics were done in Norway, but that was not the case for many, maybe just because many of them have backgrounds from other cultures. I think it is difficult to say if they have experienced mathematics as an international subject area in a more obvious way in this project, especially history of mathematics.

We are a class (and school) with many pupils with minority languages, but in the everyday work neither adults nor children think about that. It is as common or rare that someone tells us about something from Eritrea as from Vennesla (small place in Norway). The challenges these pupils have are about understanding pieces of text in mathematics with many, for them, unknown words".

Saupstad School: The pupils were very much engaged in this project. One problem was the fact that although there are many immigrant pupils they come from few countries. Thus teachers had to find a method of including more countries. This was done with drawing from a lottery of countries that the teachers had decided about. Teachers helped the pupils with sources of information in order to limit the common use of Wikipedia. They involved TV-programmes, books, library, and quality web-sites. From the photos made by the teachers it is visible how much effort the pupils have made in presenting their findings. The time-line adds a possibility to experience the historical development of mathematics.

Third piloting

by Charoula Stathopoulou[***] and Ioannis Fovos

The piloting

General Information

This activity was implemented in the school that is inside the Special Juvenile Detention Centre of Volos, with students being young detainees from all classes of Junior High School. The age of the students was from 17 to 21 years old. In the class

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there were a significant number of students who were from countries of Asia, Africa and Europe (Albania, Romania, Morocco and Pakistan). The activity was designed by the teacher of mathematics who has 25 years teaching experience in secondary education, 12 out of which in the school environment of a detention center. The activity was implemented in cooperation with the Greek teacher of the school, who had previously been informed and had prepared for this teaching intervention.

Classroom piloting

In the 1st lesson

Firstly, the students are informed of the thematic area and purpose of the class, the basic procedures of teaching and learning that would follow, as well as the way it was going to be carried out and the assessment process.

The teacher started the conversation about the international and intercultural character of the development of scientific thought, and especially of mathematics, and invited the students to contribute to the conversation by mentioning a famous mathematician, a mathematical area or a mathematical theoretical construction that they possibly knew was related to their country.

The students showed a lot of interest in the subject and willingness to engage in the class interaction, but it was noted by everyone involved that only one student was in the position to contribute to the conversation, mentioning a mathematical invention related to his country of origin.

1st activity: *the inquiry-thinking orientation*

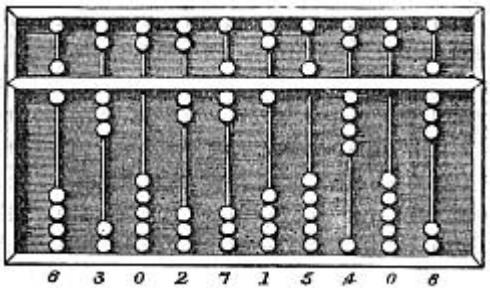
The teacher introduced to the class an inquiry-thinking orientation, projecting a worksheet with questions regarding the historical development of mathematical concepts. The class talked, formulated hypotheses and noted the need for information resources that would confirm or disprove the hypotheses in the questions talked about. This activity functioned as a pre-organizer of the activities that would follow.

2nd activity: *Mathematical inventions in different continents*

Since students came from three neighboring continents, Europe, Asia and Africa, a power-point was projected, with a historical review of the contribution of different civilizations to the development of mathematics, depending on the continent they belong to.

The presentation included:

About Asia: historical facts from Babylonian and Chinese Mathematics. The students were involved in the interaction, very few things about the existence of the Babylonian civilization were mentioned, whereas they did not know anything about Chinese mathematics.

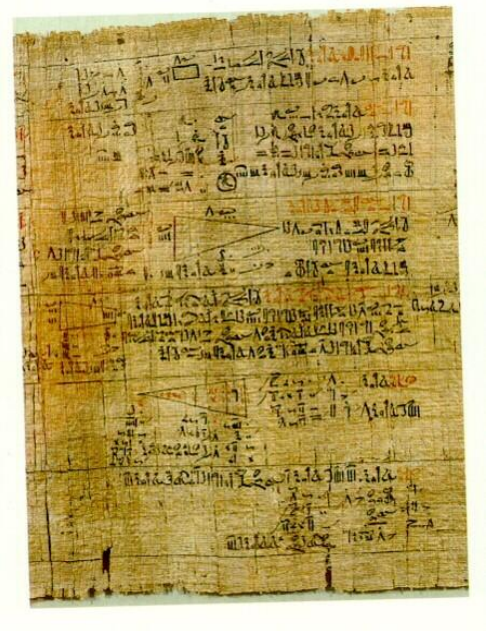


Example of Chinese mathematics achievements from Presentation

In the 2nd lesson (continuation of the 2nd activity)

Focus on Indian and Islamic Mathematics, as well as the Persian Mathematician Al Khwarizmi. The students knew very little about Islamic Mathematics. Only one student from Morocco recognized the Persian Mathematician Al Khwarizmi.

About Africa: Egyptian Mathematics was mentioned, the existence of which the students knew, without, however, being able to provide specific references to fields of its development (e.g. The Rhind Papyrus).

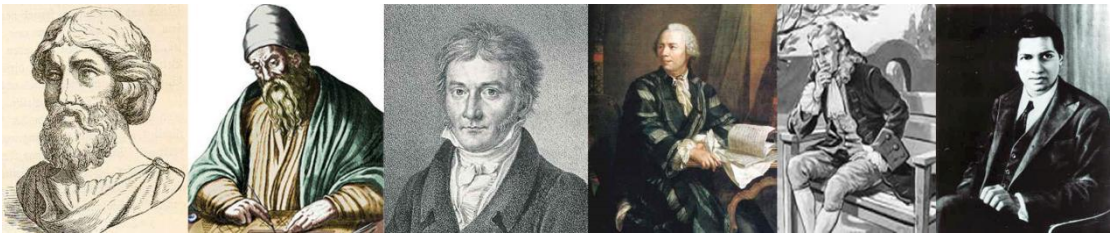


Example of Egyptian mathematics achievements from Presentation

About Europe: Greek Mathematics was recognized by all students as a milestone in the future development of mathematical science, without, however, the pupils being able to pinpoint mathematical fields where it is distinguished (e.g. mathematical proof, logic and accuracy). The tour of the contribution of the continents was completed with a reference to the era of the Renaissance.

After that, the class focused on 6 great mathematicians of all time: Pythagoras, Euclid, Gauss, Euler, Newton and Ramanujan. Some facts about their lives were presented, as well as their contribution to mathematical science. In addition, a video about Pythagoras was shown. The students actively contributed to the discussion,

recognizing the individuals and trying to connect those names to their personal experience, which are the circumstances in which they first heard of some of the names or mathematical concepts. The students had heard of all the aforementioned mathematicians, except for Euler, without, however, having any specific knowledge, with the exception of the Pythagorean Theorem.



The six chosen mathematicians

3rd activity: *Who did what in mathematics in my country?*

Due to the prohibition of Internet use by students inside the detention centre, the teacher undertook the search for information, based, however, on their own guidance.

So, after being divided into 4 groups, each one gave instructions and key words, which were going to be used to do the search. The head of the 1st group was a Romanian student, who asked for information about a specific Romanian scientist, a pioneer in aerodynamics. The 2nd group, which consisted of Albanian students, since they did not know any Albanian mathematician, asked for a search for great mathematicians of Albanian descent. For the 3rd group, which consisted of Pakistani students, since they also did not know any Pakistani mathematician, what we did for the 2nd group would be done. Finally, the 4th group, headed by a student from Morocco, asked for some great Moroccan mathematicians to be found, as well as facts about the Persian mathematician Al Khwarizmi. The common characteristic of all four groups was the fact that the information that would be brought in the next class had to be in their native languages.

In the 3rd lesson: "Studying information about mathematics in our country of origin"

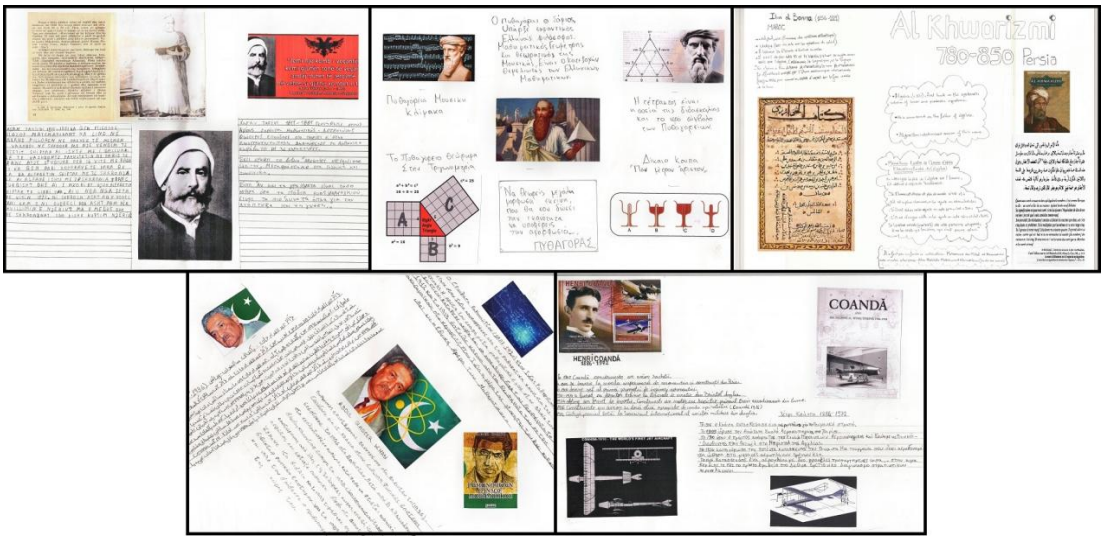
Based on the instructions of the students, the teachers had searched and stored web pages containing the relevant information in the mother tongue of the students and they presented it with the help of a projector. Each group chose the information they thought was useful, the material was printed and distributed to the members of the group, so that they could study it and record what they would put in the poster they would make.

At the end of the 3rd teaching hour, the same worksheet that had been given in the 1st hour was given, which included questions regarding everything that had been presented about the history of mathematics and the mathematicians. The students, in total, answered 14 out of 15 questions correctly, except for 4 students, who, in the 6th question about the use of the Decimal Classification System, answered "Greek mathematics" instead of "Chinese mathematics".

In the 4th lesson: "Designing-implementation of poster and whole class presentation"

All students got their paperboards and pencils and started designing the way they would place the photographs and pictures they had chosen in a suitable way and talked about the text they were going to write. The classroom was turned into a laboratory, where the 4 groups worked feverishly and the teachers moved from one group to the next, supervising their progress. Due to the special circumstances that prevail in correctional institutions, the use of some materials is prohibited, so the students had to make do with what was provided. The group with the Albanian students, because it was the biggest, made two posters, one about an Albanian mathematician and the other one about the Greek mathematician Pythagoras.

Due to the fact that the time in our disposal was not enough for them to complete their projects and because it is forbidden to take the specific materials to their cells, we continued in the 5th lesson, when, after finishing its construction, each group presented its poster, saying a few words about its content.



The finished posters

In general, those students had never before learnt anything about the history of mathematics, which they found so interesting that all of them focused, paid a lot of attention during the lessons and worked very eagerly to make the posters, with the aim of showing the importance of their country's contribution to the development of science.

Conclusions from the three piloting

by Andreas Ulovec

The piloting clearly showed that students are interested in the history of mathematics and mathematicians and mathematics content from different cultures and time-periods. The active participation of migrant students and the introduction of their cultural backgrounds can certainly enrich the learning situation. The teaching unit was well adapted to be used by teachers with pupils in different age-groups and easy to follow and engaging for both teachers and pupils. The suggested activities open the opportunities to experience learning of mathematics from a variety of sources outside the classroom.