1 10 years of Mathematics A-lympiad

What is the Mathematics A-lympiad?

The Mathematics A-lympiad is a mathematical competition for teams of 3 or 4 students organized by the Freudenthal Institute of Utrecht University in the Netherlands. The teams work on an assignment - a very open ended problem situation - in which mathematical problem solving and higher order thinking skills must be used to solve a real world problem. The result of the assignment is a written report.
The competition has two rounds: the preliminary round with about 1000 teams of students competing a day long at their own schools; and an international final in which 16 teams compete during a whole weekend on a different assignment. More information about the organization of the Mathematics A-lympiad can be found in other sections in this chapter.

Why a Mathematics A-lympiad?

The Mathematics A-lympiad owes its existence to the subject mathematics A. That sounds like it goes without saying, but perhaps this is not so evident. Since 1989 in the Netherlands in pre-university education (VWO), which is a part of upper secondary education, two different types of mathematics curricula are being taught. These are very prosaically called: mathematics A and mathematics B.
Mathematics B is the mathematics needed for technical studies and studies in science and mathematics at university level, its core component is calculus. Mathematics A is meant for students who prepare for academic studies in social or economical sciences or other related subjects. The core subjects of mathematics A are discrete mathematics, statistics and probability and a little calculus. More important than the differences in the core subjects between mathematics A and mathematics B, are the differences in the 'philosophy' and in the type of problems.
Mathematics A is a subject that has been developed with a certain purpose:

> 'Mathematics A is intended for students who will have little further education in mathematics in their academic studies, but who must be able to use mathematics as an instrument to a certain extent. In particular, we have in mind those who have to prepare themselves for the fact that subjects outside the traditional sciences are more frequently being approached with the use of mathematics.
> This means that students must learn to be able to assess the value of a mathematically tinged presentation in their education. To do this they must become familiar with the current mathematical use of language, with formulations in formula language, and with divergent forms of mathematical representation. Furthermore, they must learn to work with mathematical models and be able to assess the relevance of these models.' (HEWET-report 1980)

It will be clear that in mathematics A the emphasis lies on applications of mathemat-

ics and mathematical models more than on ‘pure’ and abstract mathematics, and also more on the processes to come to an answer than on the answer (the product) itself. Alas: Mathematics A quickly reverted to a rather meagre reflection of what it intended to be, it didn’t really meet the initial objectives as cited above. In the central final examinations at the end of VWO (grade 12) for mathematics A the open ended problems generally ask of the students only to do a calculation, draw a graph, read a graph, substitute a few values in a formula and more of that kind of triviality. Trivialities as viewed from the perspective of the objectives of mathematics A. That many of the questions are not trivial for many students is an entirely different matter, although not completely unrelated. Mathematics A has only had a short time to prove its ‘process character’. The emphasis on the ‘products’ quickly pushed aside reasoning and interpretation.
This phenomenon was foreseen, but has evidently been inescapable. An explanation for this can lie in the traditional image of ‘what a (school)mathematical problem is like’, but also in the lack of courage to meet the challenge of giving students tasks in which they really are confronted with open ended problems. The assessment by the expert, the teacher, cannot be entirely objective for such open ended problems and that seems to be a weighty argument for not including any ‘higher level’ problems in the central written examination.

Higher goals

It is certainly not an easy matter to devise real open ended problems. But if these kind of problems do not appear in the final central examinations, one cannot expect a great deal of attention to be paid to process and higher order thinking skills during education. And so the vicious circle is closed: ‘poor’ final exams bring about ‘poor’ education.
The phenomenon arising here could be that the not always meaningful results of students on mathematics A exams can be partly traced back to the fact that the supposed ‘higher order’ skills are not tested. It may be the case that students do not have an adequate command of the ‘lower’ calculation skills, but are indeed good at solving problems, at critically considering models, at mathematisation and logical reasoning.

The Mathematics A-lympiad owes its existence, at least in its conception, to the presumption of the correctness of the above hypothesis. The idea was that it would be good for mathematics A if a ‘task’ was designed that attempted to encompass the original objectives of mathematics A.
The members of the committee formed to design such a ‘task’ knew that this would be risky and difficult right from the start. But the concern that mathematics A as a

subject was being threatened, or at least was not been done justice, the desire to investigate what free forms of tasks, including teamwork, would yield, and the curiosity about what students can and cannot do, overcame the anticipated problems.

The organisation of the Mathematics A-lympiad

The Mathematics A-lympiad is organized since 1989 by the so called Mathematics A-lympiad-committee at the Freudenthal Institute. In this committee experts in curriculum development, teachers and mathematicians work together to design the assignments, to take care of the organizational matters and to judge the quality of the results of the final round.
What has remained unchanged in all these years is the structure of the competition. In the announcement that is sent to all secondary schools with pre-university education, the competition is described as follows:

> 'The competition is intended for students in grades 11 and 12 (age 16-18) who are taking mathematics A as a subject. It involves tackling a challenging problem as a team (three or four students). The competition consists of a qualifying preliminary round at the school and a final round taking a whole weekend in a conference centre in the Veluwe (a Dutch national park).
>
> The open nature of the task implies that the teams have to forge the entire path from defining the problem, via strategy definition, solution and argumentation, through to presenting the solution found. The result is a paper containing all of these aspects. [..]. In the qualifying round at the schools, the assignments are distributed in the morning at 09:00, after which the teams have until 16:00 to complete their papers. A good division of work within the team and an effective strategy are of great importance.
>
> By sending in the best papers (from a maximum of three teams), every participating school can compete for one of the twelve final places for the Dutch teams. The teachers of the participating teams assess the papers from the qualifying round.
> The final is held over a weekend in a conference centre. The structure is the same as in the qualifying round, except that the assignment is more difficult and more extensive. The teams work on it from Friday at 11:00 until Saturday at 13:00. Part of the assignment is an oral presentation.'

The statistics

Participation in the competition has seen explosive growth over the last ten years. The following table shows the number of participating schools and teams:

	The Nether-lands		Denmark		Curaçao	
	# schools	# teams	# schools	# teams	# schools	# teams
1989-'90	14	14				
1990-'91	48	117				
1991-'92	49	127				
1992-'93	53	135				
1993-'94	87	261				
1994-'95	101	347				
1995-'96	113	660	2	8		
1996-'97	106	835	5	9		
1997-'98	112	1020	6	19	2	16
1998-'99	113	1002	45	80	2	17

In the early years the number of participating teams grew almost exponentially.
It now seems that the limit has more or less been reached. The number of participating schools in the Netherlands seems almost stable. We cannot yet draw any conclusion about the number of participating teams. Surveys have shown increasing numbers of schools are participating in the competition with their complete grade 11.

Abroad

Since the school year 1995-'96 Denmark has also participated in the Mathematics A-lympiad. In Denmark the A-lympiad with its specific skills perfectly fits in with the local mathematics curriculum.
The number of schools participating in the qualifying round in Denmark is steadily growing. Danish teachers decide which two teams from the qualifying round are sent to the final in the Netherlands. The Danish teams are given the same assignments as the Dutch, although translated into Danish.
During the final, the language of communication between the Dutch and Danish students is English. After a weekend of hard work in which teams regularly work through the night, all teams present their results, without exception, in English. They also make professional use of transparencies, overhead projectors and flip charts. Very impressive.

Since the school year 1997-'98, Curaçao has also participated in the Mathematics A-lympiad. It is a natural choice for the schools in the Dutch Antilles to participate as they follow exactly the same curriculum as schools in the Netherlands. They even

use the same books. As is the case in Denmark the local mathematics teachers determine which team wrote the best paper in the qualifying round. This team is then invited to the final round in the Netherlands.

Over the last ten years the competition has grown from 14 teams from 14 schools in the Netherlands to more than 1000 teams from more than 150 schools in the Netherlands, Denmark and Curaçao. And we do not believe that this is the end.

The 'problem solving' or 'modelling' component is contained in the mathematics curriculum in many foreign countries. Working on these skills is often put on the shelf, because textbooks often don't provide good examples of appropriate tasks and teachers do not know how they are supposed to deal with this. If no structural support is provided, this component is likely to disappear from the curriculum: it will not be practised and will certainly not be assessed.
The Mathematics A-lympiad fills this 'gap' perfectly by providing appropriate tasks to practice these skills. This is both the case in the Netherlands as well as in the other participating countries. The contents of the mathematics curricula do not need to be exactly the same. In the Mathematics A-lympiad these other 'higher order' skills are being used.
Over the next few years we expect greater participation from abroad.

The A-lympiad network

Since school year 1997-'98 the A-lympiad has been organised within a network. The purpose of the network is to exchange as much information as possible among teachers about the organisation of the Mathematics A-lympiad at their schools. At the annual network meeting in the fall a great deal of information is exchanged on all sorts of practical matters: How do you organise the A-lympiad at school? How do you inform and persuade students/parents/management to participate? How do you assess the work done? How do you proceed if you want to use it as part of the school exam? But also on content related issues information is exchanged: how do you produce ideas for these kinds of tasks? Is there enough mathematical content in the A-lympiad?

In brief: the network meetings are very valuable for exchanging information. In order to give the network function more shape, a newsletter is also sent out twice a year containing as much latest news and information as possible.

Review

Looking back over the ten years of the Mathematics A-lympiad it can be said that a small experiment with a small number of schools has grown into a set component of the annual planning of the mathematics A activities, not only at around 110 schools in The Netherlands, but also in around 45 schools in Denmark and at two of the three secondary schools in Curaçao.
With more than 4000 participating students it has become the largest mathematical competition in the upper secondary education in the Netherlands.

In the early years of the Mathematics A-lympiad it was exceptional in mathematics education to call on skills such as problem-solving, reading, writing, doing research, forming arguments, reasoning, critically reviewing mathematical models, mathematisation, teamwork, planning: the full range of general and mathematical skills. In the Mathematics A-lympiad these skills have acquired a fixed place in a lot of schools in The Netherlands.
That the 'experiment' set up 10 years ago has succeeded, can be seen in the 'products'. Students prove to be able to produce papers of a high quality in response to the task in a very short period of time, showing a good command of mathematical and general skills. Papers that often surprise the real 'professionals'.

Future perspective

Future perspectives seem to be much more interesting and relevant than reviews. It seems that the growth of and the interest in the Mathematics A-lympiad are not isolated facts.
Since 1998 upper secondary education in the Netherlands is being restructured. Part of this reform is the growing attention paid to general skills embedded in the subjects. Larger tasks, which focus on these general skills as well as on subject related skills will be part of the school exam. These skills are highly reminiscent of those mentioned as objectives for mathematics A in 1980. It is precisely because these skills will be assessed in the school exams, that the interest in teaching and practising 'higher order' skills has been revived.
The assignments of the Mathematics A-lympiad turn out to be perfect examples of this kind of tasks. That they assess these skills can be concluded from the fact that producing papers in answer to the problem situation requires a combination of a large number of these skills. The Mathematics A-lympiad-committee and the teachers of the participating teams have a great deal of experience in assessing the answer papers. In addition: teamwork of students, which in the Mathematics A-lympiad is entirely normal and even necessary, is now also explicitly mentioned as a necessary skill in the examination programme.

From an organisational point of view, participating in the A-lympiad is very convenient for the school: the assignment is provided by the committee; in one day teams can produce a paper; students are deprived of the possibility of obtaining ‘expert knowledge’ from elsewhere since everyone works for the same entire day on the same task.

All in all a great deal of experience has been acquired in the Mathematics A-lympiad on all aspects of assessing general and mathematical skills by means of a larger open ended assignment. Internationally there is also considerable interest in evaluating these attempts to operationalise the ‘higher order skills’. The limitations and undesired effects of traditional testing are acknowledged and recognised. Many people are in search of suitable tests/tasks that fit within the bounds of ‘fixed time’ and ‘paper and pencil’, but which also attempt to assess the process goals and higher order skills.

The A-lympiad takes its name from the subject, mathematics A – and rightly so. The concern that mathematics A would not be able to develop into a fully-fledged subject if the testing was not appropriate has turned out to be right. Fitting the philosophy of mathematics A into the fixed examination standards has turned out to be a difficult exercise (or too difficult).

But the A-lympiad also has nothing (further) to do with mathematics A. How else could one explain that Denmark may soon overtake the Netherlands in the number of schools and in quality of the papers – if the trend continues? And other countries are also showing an interest. No, the A in mathematics A stands for *Aanleiding* (reason for) in Dutch and for *Applications* abroad. This type of mathematics is precisely the mathematics that many students will deal with later on in society: solving more complex problems in teams where technical tricks alone will not do. The only thing that shows where the roots of the A-lympiad lie is the choice of contexts, contexts -by the way- that students with more scientific interests are happy to get to grips with. That does not alter the fact that a more technical oriented A-lympiad fitting the goals and content of mathematics B would seem to be very desirable next to the existing A-lympiad.

This publication contains greatly needed information for teachers who can help students to prepare properly for the A-lympiad – as a competition, as a school exam, or simply as an extra activity. The Netherlands knows that many countries are looking this way: how will it be further developed? When will there be an English and a Spanish version? How are we going to tackle the organisational problems? Over the next five years the A-lympiad must show that it has grown up and become valuable, and must also be cross-border in the geographic sense. Because mathematics A was only the impulse.