

Gröna Fakta

Photo: Torsten Kellander



Fun outdoor exercises for easy to understand mathematics

Today's researchers agree that outdoor activities boost our feeling of wellbeing. Not only does it make us healthier, less stressed, more alert and creative – it is fun! And, the core of all motivation and learning is enjoyment. SLU (the Swedish University of Agricultural Sciences) Partnership Alnarp Landscape and Öland Association of Local Authorities support the initial phase of a project focusing on the development of outdoor pedagogy to assist in the teaching of mathematics.

The project is led by Mr Torsten Kellander, Horticultural Technician and Outdoor Pedagogue at Torslunda Experimental Station, SLU on the isle of Öland.

GRÖNA FAKTA 1/2008

Gröna Fakta is jointly produced by 'Utemiljö' (publication) and 'Movium' (Centre for the Urban Public Space at the Swedish University of Agricultural Sciences).

Shyness gives way to fun and easy m

When the participants arrive to Torsten Kellander's course in outdoor mathematics, they always start off with a fun exercise that allows them to be silly, run around and have fun. They begin to warm up and shyness gives way to the realisation that it is all right to play and have fun.

"Not having fun is not productive," explains Torsten Kellander.

Halfway through the exercise, the participants sit down for a moment of rest. It is not possible to be productive for eight hours a day. Everyone needs a break now and then.

"I am very aware of the stress and demands that the teachers face at school and I want to support them in making demands on their employers. Ultimately, it is about how we respond to and support the children."

Tangible and enjoyable pedagogic exercises are alternated with meditative experiences. The participants crawl through the damson orchard and listen to Arvo Pärt's meditative music in the Orbit House. At the end of the day, it is all about mathematics which in this case is based on the ambience of the place.

However, the project run by Torsten Kellander in the outdoor pedagogic environment of Torslunda Experimental Station on the isle of Öland is more than just mathematics. Torsten encourages the participants to come away with personal experiences.

"I want to introduce the participants to



You can learn maths anywhere, as long as you have a few simple tools. Here, students from the University of Kalmar complete a grid exercise on the grass at Torsten Kellander's maths workshop at Torslunda Experimental Station. Photo: Torsten Kellander

situations that will affect them in various ways. Based on this, I then ask them to reflect upon their personal experiences and in what direction they would like to progress their teaching. At the end of the course, the participants should go home with at least two main targets! Additional targets can be set for a period of five years. If they don't, then I have failed," says Torsten Kellander.

The concept of Torsten Kellander's flexible maths workshop works in any outdoor environment. The basic idea is that pupils and pedagogues shall use their particular maths tools in outdoor exercises for the purpose of discovering the world of mathematics in their own time.

Children who are allowed to run around and learn about the concept of mathematics through play apply all their senses and will understand the concept of mathematics throughout life. This has been recognised by the outdoor pedagogue Torsten Kellander.

After ten years working with school landscape planning with focus on cultivation and mathematics and the Orbit House at Torslunda Experimental Station, Torsten Kellander began exploring the possibility of using the pedagogic outdoor environment to make maths lessons more enjoyable and comprehensible.

"We used to calculate the weight of the pumpkin harvest and measure the vege-

Outdoor pedagogy and mathematics

Torsten Kellander is an outdoor pedagogue at Torslunda. Experimental Station, the Swedish University of Agricultural Sciences on the isle of Öland where he has created a centre for outdoor pedagogy based on his work with school landscape planning and the Orbit House. During the past four years, Torsten Kellander has developed his school landscape and outdoor pedagogy format into mathematical teaching methods. Torsten Kellander qualified as a Horticultural Technician in Alnarp and started working at the experimental agricultural estate on Öland in 1972. In 2006 and 2007, Torsten Kellander completed a course in Mathematics didactics at the Blekinge Institute of Technology. In the autumn of 2007, 'Alla tiders teknik' (Technology of all times) published the book 'Leka och lära matematik ute – förskolan' (Play and learn mathematics out-

doors – the nursery school) which Torsten Kellander co-wrote.

See www.websitefolder.net/allatidersteknik Torslunda Experimental Station is linked to the faculty of landscape planning, horticulture and agriculture at the Swedish University of Agricultural Sciences in Alnarp. The experimental station on the isle of Öland offers courses in outdoor pedagogy and school landscape planning for pedagogues working in a childcare or school environment.

For more information, visit www.litj.slu.se



Torsten Kellander works with outdoor pedagogy on Öland. Photo: Marianne Åkesson Skörd

athematics

table garden but I thought about complementing and expanding these exercises with a simple and portable maths workshop.”

Spontaneous outdoor maths

After many years working with local schools and not to forget, the teachers and pupils at Toroslunda School on Öland, Torsten Kellander realised that a lot of pedagogues would prefer to teach maths outdoors. However, the problem was that they did not always have an inspiring natural environment in close proximity to their school and hence, spontaneous lessons were not always practical.

“I wanted to provide the pupils and teachers with the necessary tools for learning about mathematics outdoors in a simple but playful and active way and whenever they wanted to.”

The initial source of inspiration was Mr

Gunnar Lindqvist, a teacher at the Elias Fries School in Hyltebruk who taught maths with the help of wooden boards.

“Gunnar gave me permission to copy the idea and I have progressed from there.”

In 2005, Torsten Kellander applied for a grant for the development of the maths project in a pedagogic outdoor environment. The following year, SLU Partnership Alnarp Landscape and Öland Association of Local Authorities decided to finance the initial phase of the project with the intention of developing the method over a period of three years for the benefit of nursery school children to year 6 pupils.

Since then, pedagogues from nursery schools and schools all over the country have visited Toroslunda Experimental Station to learn how to best apply the concept of Torsten Kellander’s maths workshop. With local nursery and primary

schools bringing along their pupils to share the experience, a gradual development of the method is taking place. As a result of the collaboration with the University of Kalmar in addition to pedagogues and pupils throughout Sweden applying the concept of the maths workshop, other ideas and teaching methods have developed since the start of the project. Torsten Kellander truly believes that he is on the right path and can tell of many instances that verifies this.

“As, for example, when a pupil described the moment of understanding as “a flurry in my stomach and pounding of my heart” and “brilliant getting the answer right with the dice!”.

Feel good outdoors

Today’s researchers agree that outdoor activities help boost our feeling of wellbeing. The fresh air and open space, daylight and exciting natural materials to experiment with - the outdoor environment is full of things that make us feel good in body and soul. Not only does it make us healthier, less stressed and more alert and creative, but it is fun to be outdoors! And, when the lesson move outdoors, many unexpected things can happen.

“Set routines and rigid roles start to break down. Pupils not doing themselves justice in the classroom often find a renewed confidence during the practical outdoor exercises,” explains Torsten Kellander.

The teamwork between the pupils and their pedagogue through playful, tangible and lively exercises in addition to a change of environment often result in a desire to discover and sporadic questions. By focusing on simple exercises that everyone can manage with a clear link to the everyday life of the child, mathematics become understandable.

Children and adults learn from each other, grasp the connection, get a direct response and have fun together. Discovering mathematics becomes an enjoyable and satisfying experience.

Naturally, the appearance of the environment where the exercises are carried out is important. The best possible exercise environment includes a variety of components such as a tarmacked or grassy surface, a gravelled path, different types of trees including fruit trees, interesting hedging



What is six minus six dots? Our senses are stimulated by the outdoors and maths takes on a new angle when you are allowed to use your body unhindered. Photo: Torsten Kellander



Hmm, now what is six dots minus two dots? Mathematics becomes more comprehensible when using dice and a maths board. Photo: Torsten Kellander

plants and bushes, boulders, rock faces and other gradients, flowers, soft fruit plants, a vegetable patch and if possible, a wild growing area. Natural 'materials' such as leaves, fruits, home grown vegetables, chestnuts, pine nuts, sticks and small stones are also good to have although these can of course be collected during an outing and brought back to the workshop.

"Although the basic idea behind my maths workshop is that it should work just as well in a garden as in a park, forest or barren city school yard," explains Torsten Kellander.

Portable workshop

The maths workshop does not need to take up a very large area of the school yard and since the material is portable, nothing stops it from being moved to another location.

Usually, it does not take long for nursery school teachers to see how they can transfer the material used in the maths laboratory to other diverse natural environments. For example, grids can be drawn in sand, painted on snow or built with sticks in the woods.

However, the maths workshop described in this article does require small grassed and tarmacked areas to achieve the optimum result.

It is also beneficial to create a couple of attractive and slightly secluded school yard

meeting places where the children - either two by two or in a group - can meet to reflect and discuss an activity.

The idea behind the maths material developed by Torsten Kellander for use outdoors by children, pupils and pedagogues is primarily to promote both spontaneous and planned maths exercises. Still, the most important aspect of the material used in the 'maths lab' (as described in the next article), e.g. wooden boards, vests, grids, dice and rope stumps is that they are easy and inexpensive to make.

"Nursery and primary school children who are involved in the making of the maths lab material together with their pedagogues will take responsibility and feel part of the process. Making the maths tools together will also give everyone an insight into the mathematical world," says Torsten.

For example, spraying a grid on the grass illustrates quite clearly how large a 0.5 by 0.5 m square is 'in reality'. And if you have to measure the length of a wooden board made up of five sections with each section measuring one metre, you soon become familiar with the metric system.

By using a folding rule and a measuring tape, the children really get to understand the different measurements.

The material used in the maths workshop should of course appeal to as many of our senses as possible and consequently, a lot of colours are a must. In addition, the

material should be hard-wearing to withstand outdoor storage, perhaps in a shed or under a roof. In this way, all maths tools are easily accessible for spontaneous outdoor lessons.

The subject of the maths lab can of course be varied endlessly and children often invent completely new or a combination of old exercises. At the same time as the method is modified to the requirements of the school, new 'tools' may be invented to add to the existing workshop supply.

"If everyone is allowed to partake in and take responsibility for the planning, invention and making of new tools, then the maths laboratory becomes a project that follows the progress of the pupils and develops from year to year," says Torsten Kellander.

Preparation and reflection

Torsten Kellander repeatedly reiterates the importance of time. And, he is not just talking about the time it takes to do the practical exercises outdoors and encourage teamwork.

"It is essentially about children and adult explorers having the time to collectively and calmly reflect on what they have found and how, i.e. not to rush the process and instead do fewer exercises to gain a deeper understanding."

First of all, the pedagogue should carefully prepare for and think about why she/he has chosen a specific exercise. What is the purpose with the exercise? What do I want the pupils to learn and understand? Which mathematical concepts and keywords will the pupils come across and do they understand what these mean?

"By practising indoors, the pedagogue can see whether the children have actually grasped the difference between various measurements - or the outdoor exercise will not be constructive," says Torsten Kellander.

At one school, the classroom children were asked to think of different mathematical concepts relating to the measuring of a length. What is longer? Seventy centimetres, seven decimetres or a metre?

One way is to measure the length of the floor using a ruler, folding ruler or a string while another is to guess the answer, argue one's viewpoint and consider the opinions of other classmates.

However, to begin with, it would be helpful to explain the concept of length by asking the pupils to line up according to height and then describe and explain the exercises that the pupils will be doing out-

side. The pupils can also form groups and try to come up with new exercises for their school friends.

When doing the outdoor exercises, the pupils must be given time to find alternative solutions to a maths problem and to see and understand how a friend managed to solve a problem, discuss the method used and agree on an answer.

“In this way, everyone can see that there is more than one explanation and solution to a problem.”

Process and understand

The solutions found by the pupils and pedagogues are then processed. Perhaps not everyone has had the time to see how a friend managed to solve a specific problem or to understand the implication of one's own conclusions. It is important to assess whether the exercises have helped the children to better understand the words, concepts and keywords discussed prior to the exercises and to link their newfound knowledge to certain mathematical concepts, understand patterns and ask new questions that will lead to other areas. What did you do and why? Could you have done it in any other way?

“In this way, children as young as six will become familiar with mathematical words and terminology and manage to link a word to a mathematical concept,” says Torsten Kellander.

The processing, outdoor exercises and

Nothing compares with inciting the need for and love of knowledge or you would only create packing mules.

Michel de Montaigne

preparatory work should of course be adapted to the individual needs and age of a child. Small children do not have the stamina of older children and lose their concentration after about fifteen minutes. A short break with a lively and simple maths game is then welcome.

Naturally, it is important for the adult to be flexible and responsive at all times, especially in the company of older pupils, and to reassess the situation when a group of pupils is unable to keep up. Torsten Kellander remembers when a group of restless Year 7 pupils was asked to do some exercises relating to time.

“It did not quite work according to plan, so I thought that they probably needed to get rid of some energy.”

Every pupil was asked to run a distance of thirty metres while a friend clocked the time on his/her mobile telephone!

The final result varied with precise timings from 4.1 to around 5 seconds. After that, the pupils had to figure out in which square in the grid on the lawn that she/he should stand with her/his time. A fairly advanced exercise in the art of rounding off that the pupils solved independently without a problem.

In order to do the exercise, the pupils needed to put their thinking caps on and

discuss the activity. Torsten Kellander believes that these outdoor exercises and the maths workshop do not only create a greater understanding of mathematical concepts.

“By using all senses in a stimulating outdoor environment and trying different ways in which to solve a problem, children and adults are given the opportunity of finding the method of learning that best suits them. We are all different!”

Over time, Torsten Kellander would like to see the outdoor teaching method being used by a growing number of pedagogues, regardless of whether it is his own method or that of someone else. What is most important is that the pedagogues give the pupils a chance to become familiar with different and other ways of learning about mathematics.

“All pedagogues should have the opportunity to study and develop outdoor pedagogic skills, not least in mathematics.”

Perhaps Torsten Kellander's vision for the future is about to become reality when the new partnership with the mathematical didactics at Växjö University starts in 2008, giving the teachers of the future an opportunity of teaching mathematics outdoors to pupils from Year 6 to Year 9 as well as sixth-formers.



The concept of maths can also be taught using home grown vegetables. A little fun can do no harm! Photo: Torsten Kellander

Making your maths tools generates re

The maths lesson starts with the pedagogues and pupils together making the maths tools. Involvement increases the feeling of commitment and responsibility. Colourful wooden boards, dice and reflective vests stimulate the senses. These simple teaching materials have endless uses.

All maths tools should be kept close at hand to facilitate easy access whenever needed. After all, the idea is that nursery and primary schools situated far from nature shall be able to teach mathematics in the school yard whenever they want to. However, it would be an advantage if the nursery or primary school yard had grassy, gravelly and tarmacked areas.

If there are no natural materials close at hand (e.g. pine cones, pebbles and sticks), then these should be collected as mathematics is not just about counting and learning figures. It is also about volume, positioning, sorting, comparing and making an assessment based on various criteria in

addition to colour, shape, weight and size.

Filling the maths workshop with appropriate materials is a process that should be allowed to take time. When nursery and primary school children make the maths workshop tools together with their pedagogues, an exciting joint discovery of the world of mathematics occurs.

The exercises described below can be varied to infinity and are only limited by a lack of imagination. However, it is always important to prepare the pupils for the exercises. What do you want to achieve and make easier to understand? It is particularly important to go through and put into practice different concepts and keywords that may crop up during the exercise. Does everyone understand the metric system, e.g. seven decimetres being shorter than one metre? How can this be better explained?

It is also important to think about and discuss how the children used the boards, vests and grid. The children's own thoughts do not only shed light on what they have learnt and what method of learning they prefer. They often induce 'Aha!' moments among the other participants.

Most importantly, the children learn to realise that a problem can be solved in more than one way, using a number of strategies – none better or more accurate than the other!

Wooden boards

Planned wooden boards can be bought from the nearest builder merchant at a standard length of 3.6 metres. The boards are reasonably easy to handle and using a marker pen, the surface of the wooden board can be divided into ten equally large sections with a number in each square, e.g. from 1 to 10, from 11 to 20 and so forth.

The numbers can also be replaced with symbols (dots, stars, etc.) with one dot in the first square, two dots in the second square, etc., similar to the dots on a dice. Position the boards alongside each other to reveal the actual number and corresponding amount of dots.

Exercises using a number scale and '10-friends'

Using the wooden board with numbers from 1 to 10, ask the smaller children to step into each of the squares while calling out the number of the squares. Then see if the children can figure out what number they would get to if adding 1 to 2 and to step into the correct number or symbol square.

The older children (from five years) can be divided into groups of two with each pair being given a note with $2 + 3$ or $1 + 1$ and so on with the total sum not exceeding 10. Then ask each pair to add up the numbers on their note and step into the square that corresponds to their sum total.

For the '10-friends' exercise, put the children into pairs. One child steps onto a number square while the other figures out which square he/she should step into to make up the number 10 together with his/her friend.

The strategies applied by the children to find the correct answer usually varies. Some pace the board, others do a mental calculation while others still count on their fingers.

Reflective vests

Most nursery and primary schools have a supply of reflective vests. By writing diffe-



The meeting place is where everyone can take a break, think about what they have achieved and put words to their experiences. Photo: Torsten Kellander

responsibility and stimulates all senses



Pupils learning about number ten with the help of wooden maths boards. Photo: Torsten Kellander

rent numbers on the vests, they can then be used for different exercises. See Exercises with a number scale and '10-friends' above.

As an example, ask the children to line up in numerical order. The vests can also be used for practising the concepts of behind, in front and beside.

Alternatively, ask the children to collect the same number of pine cones (sticks, pebbles) as the number on their vests and talk about which number that is greater and/or smaller than another number. Practise odd and even numbers by asking the children with odd numbers (or vice versa) to close their eyes. The children with even numbers and their eyes open can then together try to guide everyone into a numerical line-up.

The vests are perfect for active mathematical games that involve running around or hugging a '10-friend'. The complexity of the games should vary according to age.

Grid

Paint or draw a grid directly onto a grassy or tarmacked surface using white spray paint, special line marker equipment or chalk. The grid should consist of one hundred or ten by ten half metre squares. You can also make a temporary grid with food colouring in the snow or by drawing lines in the school yard sand. The grid is perfect for training positional terminology and the concept of space.

Exercises

The grid can be used to pace out and clearly explain the concept of a bar chart. For example, how tall is the chart that has ten stones compared with the one that has five?

In addition, the grid can be used for various decimal and rounding off exercises such as when the Year 7 pupils mentioned above measured the time in seconds.

Dice

Ready-made, large dice can be bought from a shop or made in wood. The benefit of using dice is that they can easily be combined with other maths workshop materials.

For example, the concept of addition and subtraction can be explained by covering one or a couple of the dots on the dice with your hand (and then remove your hand).

"Our first teachers of philosophy are our feet, hands and eyes. To substitute books for them does not teach us to reason, it teaches us to use the reason of others rather than our own; it teaches us to believe much and know little."

Jean-Jacques Rousseau

Dice and boards

Dice and boards can be used to practise subtraction across all ages.

This exercise was developed by Birgitta Andersson and pupils from Year 1 to 3 at the Torslunda School on Öland. The advantage of mixed age groups is that the children will learn from each other. Another advantage is that everyone can be active together, eliminating any boring waiting around.

Subtraction exercises

This exercise requires a maths board numbered from 0 to 5 and two dice but before starting the exercise, it is important to talk about the highest numbers on the dice.

Ask a pupil to throw a dice. The dice shows 2. Then ask another pupil to throw the other dice. The total of the two dice is 4. What is the difference? The correct answer is 2! Mark the correct answer by putting a colourful note on the corresponding number on the maths board. Continue in the same way until all numbers are marked. This exercise can also be used as a competition between two groups of children.

Other material

The maths workshop materials can obviously be alternated and supplemented without end. For example, the three metres long maths boards can become foldable and portable if replaced by an oilcloth.

Moreover, the outdoor environment is full of free material that can readily be used for different maths exercises. Pine cones, small or large stones, leaves, twigs and fallen fruit can be counted and/or sorted according to colour, shape, weight, length, etc., either individually or in combination with the boards, grids and vests.



Pupils from the University of Kalmar practise geometrical shapes using a rope. At the maths workshop, there is usually more than one solution to a problem and everyone can find the way that suits them the best. Photo: Torsten Kellander

This 'Gröna Fakta'...

...was written by Torsten Kellander, Outdoor Pedagogue at Torslunda Experimental Station, the Swedish University of Agricultural Sciences and Eva Selin, Chief Editor for the periodical Familjedaghem, Fortbildning AB Stockholm. Eva Selin is also the author of 'Rum för utelek' (Room for outdoor play), Fortbildning AB. Cover: Teachers from the United Kingdom, the Slovak Republic, Italy and Germany have visited the maths workshop at Torslunda Experimental Station.



MOVIVUM

Gröna Fakta is produced by Movium, SLU, Box 54, 230 53 Alnarp. Tel.: +46 (0)40 41 50 00. Editor: Titti Olsson. ISSN 0284-9798. Published in Utemiljö 1/2008.