Introduction
There is mathematics to be found in the streets. The world around us provides many opportunities to come up with ‘mathematical’ tasks based on everyday situations. Realistic problems lead to authentic presentations of questions to be tackled by pupils of various levels. In maths classes pupils are confronted with descriptions of everyday situations they have to use to answer questions. These descriptions are not needed in maths walks, where the situation is a tangible given and makes the questions more obvious. Moreover, pupils are encouraged by the discovery that maths knowledge and skills actually help them to cope with many real-life problems. Reason enough to get out of the classroom and take a walk in the school’s surroundings.

1. Realistic mathematics teaching

The point of the maths walks is to learn to recognize mathematics in the world around us. As soon as something can be seen or calculated in realistic situations, it becomes clear how mathematics can be applied. In maths walks there is plenty of scope for the use of knowledge and skills learnt in maths lessons. These have to be applied in new situations. The pupil does not know beforehand what knowledge is useful in a particular situation, therefore this can lead to a great diversity of approach. The development of individual ways of solving problems is an important objective of realistic mathematics teaching, and maths walks give an opportunity to practise this skill.

Illustration: How large is the angle between the Lindengracht and the Brouwersgracht?
(2 photos) 4046 and 4047

In this example the angle between the walls of the Lindengracht and Brouwersgracht proves to be easy to find on the kerb. In this case it is a matter of parallel lines. Then it is simple to measure the angle with a set square.

Learning from contexts is typical of realistic mathematics teaching. Meaningful tasks are formulated in a realistic context . By examining a number of different situations, the pupil discovers what is always ‘the same’ in these situations. For instance, a number of different situations involving linear relations, should lead the pupil to make a distinction between fixed and variable costs, fixed and variable times, fixed and variable yields, etc. The fact that fixed and variable items keep cropping up then leads to designating them as constants or variables. They can then be recognised in a formula. A general formula will then prove useful in each of these examples. In this way an abstract concept – in this case linear relationships – develops from the reality and is understood.

Although the maths walks offer a great variety of contexts, it is not sensible to develop new concepts from it (on the street). There is too little attention and time for this in such a situation. However, after a maths walk it is possible to go back to the experience in a lesson. It is then quite possible to use the real contexts again to develop new mathematical concepts. For instance, counting the number of people going in and out of a shop can lead to a discussion about forecasting the number of visitors. In this way maths walk contexts can be used for a series of lessons.
In maths walks we aim to bring pupils into situations of daily life in which they see that you can recognise, use and discover mathematics. Maths turns out to be versatile, interesting, enjoyable and sometimes surprising.

2. Using realistic contexts

Many mathematics teachers make use of realistic contexts in their lessons. Teachers try to make mathematical concepts as comprehensible as possible for their pupils and this is sometimes best done by placing them in situations the pupils can recognise. After all real-life situations appeal more to the imagination, so that abstract concepts gain meaning and are better absorbed. Contexts are then deployed as examples, from the point of view of teaching mathematics. There are, however, other possibilities. A context with questions in which problems can be solved by mathematical means shows how mathematics can be applied. In this way it becomes clear what the value of maths is in such problematical situations. Contexts may also be used for their value in motivation, to show that mathematical skills are useful for making decisions in daily life. In short, in today's maths teaching very many realistic contexts are incorporated for a variety of reasons.

Presentation of contexts in the classroom

The presentation in the classroom of a realistic context is generally provided by the authors of the book. They take a great deal of trouble (and words) to make all the details of the situation clear. After all, pupils must be able to envisage the situation clearly to be able to decide

- what information is relevant or not relevant,
- what information is needed to answer the question, or even
- what question you could ask in such a situation which could be solved mathematically.

Obviously the teacher can use other means than just the book to make the reality appeal as vividly as possible to the imagination of the pupils in the classroom. An (imaginary) story, a photograph, drawing or a video could also lead to the development of mathematical problems. In addition material put in front of the class can form the context from which mathematical questions, as it were, appear of their own accord.

The intention is to bring a realistic situation into the classroom in one way or another. For this purpose real situations have to be described, displayed, and if possible supported by visual evidence. There is, however, always the drawback that the description of a situation already provides a selection of the relevant information offered by a practical situation.

Contexts during a maths walk

During a math walk pupils walk in small groups past a number of realistic contexts. The advantage of a realistic situation in a maths walk is that the situation virtually presents itself. What questions can be asked? What is relevant here? Can the question be answered easily and quickly here, or is it important to go to work accurately and with precision? What are the possible ways of solving it? Quantitative or qualitative research? Such questions do not need to be raised separately, they more or less force themselves on you when looking at the real situation in front of you. Pupils have to find relevant measurements and data for themselves and detect what other possibilities the situation has to offer. That makes the application of mathematics more authentic.

Example

The context of a wheelchair ramp is a good one to use for calculating angles by means of trigonometry. In the book the context is presented with a (mathematical) sketch. The small drawings should boost the imagination of the real situation. Therefore a photograph is also added.

(Wheelchair ramp G&R)

A series of sub-questions leads the pupil to the crucial question of whether this wheelchair ramp meets the legal standard.
Precisely during a maths walk a question can imply a challenging task which can be solved by measuring the correct distances. ‘Determine the the angle of inclination of this entrance for wheelchair users. Does it meet the legal standard?’ In this situation pupils should be able to recognise a useful right-angled triangle, measure the distances which are easily measured, and on the basis of that decide whether sine, cosine of tangent are applicable.

3. Designing a maths walk

A few tips.

The idea for a walk starts by having a good look around you. A (digital) camera is very useful to record all kinds of situations from which ideas can be developed later.

<photographs of lampposts> 4078, 4079, 4048, 4049, 4028

Look at all those lampposts. What can I see in them? Top view, bottom view, construction, … What does the outcome suggest? Symmetry, equilateral trapezium, ….

- Tip: Go for a walk with a colleague who also teaches maths. Two can see more than one. You will inspire one another to come up with suitable questions.

When a number of situations have been identified, the temptation is great to attach more questions to each situation. You will often see more and more possibilities. Yet that is not sensible for a maths walk. If pupils have to stop too long at a single object, their concentration flags and they lose interest. Maths walk contexts should call for a specific activity or pose a question that needs brief consideration. The answer should be simple to write down.

Photo 4025: photo 167
How many bicycles are parked here? What is the angle of inclination of the cycle rack? Draw a side view. How high is the rack above the water?

- Tip: don’t stop too long by one object, keep moving.

The time spent walking from one task to the next must not be too short. It gives the pupils time to think a little more about the situation and if necessary discuss it among themselves. That will occur more easily if the approach to a problem is not too obvious. Or if the outcome turns out to be surprising.

<How many times would the small house standing apart fit into the great pyramid? (From the Amsterdam maths walk by Hans Wisbrun) <photo 4040 and photo 163>

About 54 times! Who would have thought it?

As a matter of fact, walking in itself keeps the tasks coming. The time spent walking is also used to bring you to a new object that will rekindle your interest.

- Tip: make sure a maths walk is a real walk as well as a maths lesson.

Along the route there may be an interesting situation in a side street which you don’t actually want to go down further. Pupils will be walking in an out of the street all the time. This has proved to be impractical. Pupils meeting one another going the other way often think that they

are going in the wrong direction. If that is the case it makes sense to incorporate the situation into another part of the route, or leave it out all together perhaps for these reasons.

- Tip: Don’t let pupils walk in opposite directions to each other; it will only confuse them.

Some questions can be answered quickly and without extensive discussion, while other questions demand measuring and perhaps further activities. The strength of a maths walk is precisely that the contexts alternate in quick succession, so the questions also have to be alternately long and short. Variety can also be achieved by alternating arithmetic, geometry, algebra and statistics. It proves to be particularly easy to find geometrical problems on the street.

- Tip: Make certain there is enough variety.

Once enthusiasm has been aroused, the temptation is great to make a maths walk too long. It may be a good idea to split a walk into different projects for academic and vocational streams. Or that two groups take two different walks, with the same check points. Experience teaches that after about one hour you do no longer show an interest for new objects. That means that your pupils will give up even earlier.

- Tip: Don’t make the walk too long, an hour’s walk is too long.

When the situations have been assembled and selected, and the questions drawn up, it is important to give some thought to the documents the pupils will take with them on the street. There should not be too many sheets of paper, but there should be enough space to write, draw or calculate. Digital photographs printed on a colour printer look inviting. Remember that the pupils will have very little time to read on the way. The number of sentences should be kept limited and above all set out succinctly.

- Tip: give thought to the lay-out of the material.

Make sure someone else walks the route before using it. This is best done by pupils, possibly from a higher form than those for whom the walk is intended. This try-out can bring to light plenty of minor imperfections. Particularly formulating simple but unambiguous questions can be difficult. The route description should not take on the form of a treasure hunt, there is enough to think about without that.

- Tip: Let someone else try out the walk first.

4. Example

London maths walk

Maths walk London

Practical mathematics project

→You should do this walk in a group of <u>not more than 4 people</u>. Note the names of the members of your group on your worksheet.
→Essentials: pen, calculator, set square, protractor, measuring tape, copied extracts from your book, camera.
→NB: make a note in the boxes on your worksheet of the *<u>time</u>* at which you arrived at each particular task.

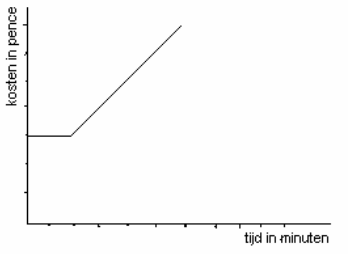
→The maths walk starts at Temple underground station.

→As you come out of the station, turn right. Round the corner to the right is a typical English telephone booth.

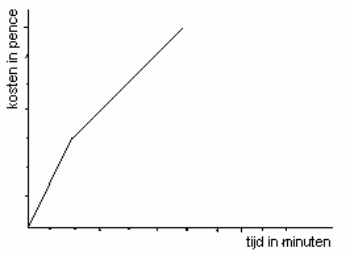
1. a. Find out how much it costs to talk from this phone booth for 30 minutes if you pay in coins.
   Explain how you arrived at your answer.

   b. Fill in the table on your worksheet.

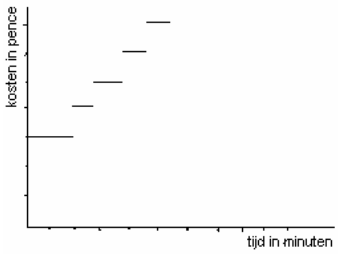
   c. You can show the cost of a phone call by a graph.
   Which graph suits this situation?
   Note: translation of the subscrip .Vertical: cost in pence, horizontal: time in minutes.



A



B



C

→At the traffic lights cross the road towards the Thames. Mind the traffic; first look <u>right</u>, then left!!

→On the other side, on the riverside (walk a little to the right) you will see a silver-coloured display stand with an information chart. It tells you what there is to see on the other side of the Thames. There is a bench by it.

2. a. Look for the tallest building on the other side.
   What is it called?

   b. Estimate the number of floors in that building.
   Explain how you did that.

c. Approximately how high is this building in metres?

3. a. Use the information chart. Look at the scale and fill in your worksheet.

   b. If I walk from **Blackfriars bridge** to **Westminster bridge**, what will be the difference in distance between the route on this side and the route on the other side of the river? Show how you arrived at your answer.

→Turn right, walk on the pavement alongside the Thames, with the water on your left hand.

→Just before the bridge you will see a building across the road: 'Somerset House'.

4. a. List 3 features from which you can see that the facade is built symmetrically.

   b. Make a sketch of these 3 characteristics.

5. The river Thames flows through the centre of London. Chester and Victoria are taking a cruise on the Thames. If the boat sails at 12 km per hour, how many km will it travel in 35 minutes? Write down your calculations.

→Walk on under the bridge.

6. What is the name of the bridge?

→If you walk on, you will at some point see a building with a clock on it on your right, on the other side of the road. (If you get to the next bridge, you have walked too far!!)

→F1. Take a photo here. Make sure that the whole group (except, of course, the photographer) *and* the clock are on it.

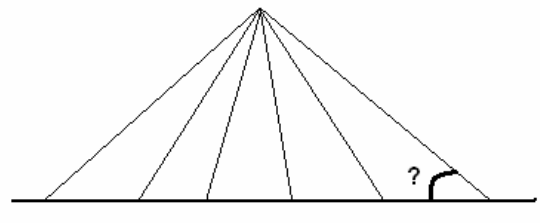
7. What must the photographer do to get it all in the picture?

→Walk on again. Take a good look around you and enjoy what you see. When you have gone a little further you will see the next bridge in the distance. This is a suspension bridge (= a bridge with steel cables) for pedestrians, with a railway bridge next to it. Stop for a moment and have a good look at it.

8. Make a plan: how could you determine the length of this bridge? (You will soon be walking across it!) You need not do the calculation now, just make the plan.

→Walk on to the bridge. Stop just before it. Stay on the pavement for a moment. Look at the bridge.

9. What angle does the <u>outer suspension cable on the right</u> make with the handrail of the bridge? See the illustration!



→Cross the road at the pedestrian crossing, take care: traffic comes first from the <u>right</u>, then the left! Go up the steps to the bridge.

10. While you walk along the bridge to the other side of the river you carry out your plan.
    a. How long is that bridge? (Starting from the steps.) Write down your calculations.

    b. Did you stick to your plan?

Enjoy the view from the bridge! If your photo of your group with the clock was not successful, you can try again from here!

→On the other side of the bridge you go straight on down the steps and then down to the right, passing under the railway bridge. This time the water is to your right. Wait at the bottom.

11. You have walked down a slope for part of the way. We will now <u>calculate</u> the angle of the slope. Use your measuring tape and your calculator.

a. Determine 2 of the 3 sides of the sketch on your worksheet (in reality!!). Write down how you approach something like this.

b. Write the data you have found on your sketch (you only need to list two!).

c. With these two sides, calculate the angle of inclination H.

d. Try to measure the angle (for real). Does it agree more or less with your calculation?

→At the bottom of this slope (under some steps) you will see a small bicycle rack. It consists of tubes, two small and four large ones.

12. The tubes are shaped into a bent cylinder. We are going to calculate its volume

    a. Measure a large tube and fill in your worksheet.

    b. From the measured lengths calculate the average length of the tube.

    c. Write down the formulae for the circumference and area of a circle and the volume of a cylinder.

    d. With the measured circumference calculate the diameter and the radius.

e. Calculate the surface area of a circle with this radius.

f. Calculate the volume of such a tube.

→Walk to the Ferris wheel.

13. a. What is it called?

    b. How many capsules are there (a capsule is a sort of box)?

    c. A capsule can carry 25 people. The capsule takes 30 minutes to go round
    How many people can use the wheel per hour? Write down your calculation!

    d. This number is a maximum. The actual number will be rather lower. What would you expect the actual number to be? Explain your answer.

    e. The wheel is open every day from 9.00 – 20.00 hours. How many people would you expect to take a ride in it per day? Explain.

    f. The wheel is 135 m high, there are 80 spokes, you see some 40 km from it in good weather.
    Calculate the distance a capsule travels in a single circuit. Write down your calculation.

g. How fast does such a capsule travel? Write down your calculation.

h. If you make a graph of the height of a capsule against time, will it look like this?

What relationship is this?

→If you want to you can go on the wheel. The view is fabulous! Watch out, you may have to queue a long time. It can easily take an hour. You have to pay for it, about £6 (children) or about £12 if you are over 16 years. The maths walk will last another quarter of an hour from here.

→We walk on. You will come across a few works of art by Salvador Dalí. In one of his works, opposite the Aquarium, there are mathematical shapes.

14. Which mathematical shapes?

→You cross the bridge again, back to the other side of the Thames. Take a good look round! Below are three photographs of a building. Can you see the building?

A

B

C

15. Part of a map of London has been drawn on your worksheet. Show with large dots and the letters A, B and C where the photographer stood to take the photographs.

→At the end of the bridge look to your left, on the other side of the road (don't cross it!!), the Houses of Parliament (next to Big Ben).

16. There is regularity in the architecture. In the photo on your worksheet show with 2 stripes what period it is.

17. A group of people visit Westminster Abbey (you are now quite close to it!). Children under 11 can go in free, children from 12 to 16 pay £3, people over 60-also pay £3, adults pay £6.

    a. How much will it cost 5 adults, 2 pensioners, 8 primary school children, and 10 teenagers to go in, if you also get a group reduction of 5 %?

    b. Approximately how much would it cost in euros?

→**F2**. Look at Big Ben. Take a photograph here. Make sure that all members of the group (except, of course, the photographer) as well as the clock are on it..

→Take another good look round. The walk ends at Westminster underground station. Here comes the last question:

18. Show on the plan in your worksheet where you have walked, marking your route in colour. You may like to use your own plan (in colour) to see it all clearly.

→Discuss with the members of your group: Have you got everything, has each one of you filled in a worksheet? Have you taken the photographs? You can go and sit somewhere to finish it off tidily.

→Hand in your worksheet and any borrowed equipment to your group leader. The photographs you can hand in after half-term at school. Good luck with your other tasks and enjoy the rest of your visit to London.