This resource is part of a suite of materials and activities created to inspire entrants, and support teachers, and parents to enter *maths inside*: a photo competition open to everyone in Scotland. *maths inside*: see different, make connections, celebrate!

In this series of example submission journeys, you can find details of searching, questioning, and discovery of *maths inside* the things and spaces around us! Follow these stories and learn how to catch the beauty of a discovery in a photo, title and commentary (linked activities and resource pack).

Visit mathsinside.com for entry details, further information, and follow us for updates!

Below, this example documents the submission journey for an **Third/Fourth Level (S1–S3)** entry (credits).

Shoelace Combinations | Third/Fourth Level example submission journey

I recently bought a new pair of running shoes and I was messing around to try and find the best way to lace them up so that they were secure on my feet. It got me thinking – how many possible ways are there to lace up your shoes? I decided to use this for my maths inside entry and came up with the title
> "shoelace combinations"

and commentary

> "I was tying my shoes and considered the different ways I could lace them up to stay on my feet."

I also took the photo below.

I wanted to improve this commentary by thinking more about the maths involved so I thought of some questions to answer. How many holes do the laces go through? Why do all the holes need to be used? What happens when a hole is used twice? I thought a little more about the number of holes the laces go through.

Using only some of the holes will decrease the number of possible shoelace combinations. In some cases, it might be sensible to avoid using some of the holes but in other cases it isn't. For example, I can choose to use the holes on only one side of the shoe but this would be daft as they wouldn't stay on my feet. I can use a hole twice but doing this would increase the number of possible shoelace combinations. By thinking a bit more about this I now have the commentary:

> "I was working out the best way to lace up my running shoes to make sure they stayed on my feet. This got me thinking about the different ways I can lace them up and how many different combinations were possible. My trainers have 8 holes for the laces. I can choose to use only 6 of them which would decrease the number of combinations I can choose from. I can choose to use a hole twice which would increase the number of combinations. Not all the combinations are sensible though because if I choose to feed the lace through only one side then my shoes won't stay on my feet."

What do you think of my commentary? Can you improved it further? I think so! I set myself some rules to make sure that the patterns I choose are sensible and don't leave me slipping out of my shoes. I wrote down what I wanted for the shoe lace patterns

- I want the lace to pass through each hole only once
- I am only going to choose a pattern where my shoes will stay on my feet
- I want the pattern to start and finish at the top holes

With these rules I've created in mind I can add to my commentary:

> "I was working out the best way to lace up my running shoes to make sure they stayed on my feet. This got me thinking about the different ways I could lace them up and how many different combinations were possible. My trainers have 8 holes for the laces. I can choose to use only 6 of them which will decrease the number of combinations I can choose from. I can choose to use a hole twice which will increase the number of combinations. Not all the combinations are sensible though. For example, choosing to feed the lace through only one side will cause my shoes to fall off my feet. To avoid these problems I set myself some rules. The lace can only pass through each hole only once, I can only choose a pattern where my shoes stay on my feet and my lace can only start and finish at the top holes. By setting myself these rules it allowed me to reduce the number of possible shoelace patterns and also remove the patterns that weren't a sensible choice."

I also took another photo to show all of the combinations I had found with my rules.

How can this photo be improved? I like the composition with the six shoes arranged in three pairs, but there is too much floor and not enough shoe laces framed in the for me to show off all these combinations! I decided to crop this photo for my final entry.

further things to think about

There are even more questions I can think of to discover more about the lace combinations!. How are the patterns the same when the shoes are laced up from the right or left first? Where are the differences? Can you have identical patterns? How can the number of patterns be reduced further? What new rules can be made? Why have patterns that are symmetrical? What patterns can be discovered using more than one lace? How many possible shoelace combinations are there? What rules do you want to have? Why?

Open to all ages with prizes in each level. You only need a mobile, the internet & curiosity! Enter maths inside *on your own or as a team, mind to add the maths inside sticker, and submit in one, or in as many categories as you like. The photo should be your own, without changes, and for a chance to win, cannot be shared anywhere else. View the* T&C *for more information, and please do get in touch if you have any questions.*

linked activities and resource pack

Complementing each journey is an example interdisciplinary learning (IDL) activity matched to Curriculum for Excellence experiences and outcomes (Es&Os). Also available are image banks containing images and questions to inspire interdisciplinary investigation and learning. These resources and activities are all available in a downloadable pack.

credits

This suite of resources are the fruit of a collaborative project between undergraduate and postgraduate students from the University of Glasgow — School of Mathematics & Statistics, Education Scotland, and Dr Andrew Wilson (*maths inside* Founder and Director).

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The photos above are credited to Emma Hunter.