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 **Second Level (P5–P7)** entry (credits).

Goal? | Second Level example submission journey

During a match against Serbia, I was glued to my TV, desperately hoping that Scotland would win the penalty shootout and send the team to Euro 2020. This made me think, how do the players know which way to shoot? I had a great photo of a penalty being taken, and I wanted to use this for my entry into the Maths Inside photo competition, so I thought of a title – "Penalty Shootout" – and a short commentary for my photo:

> "The striker is trying to score a goal and the goalkeeper is trying to stop the striker from scoring a goal"
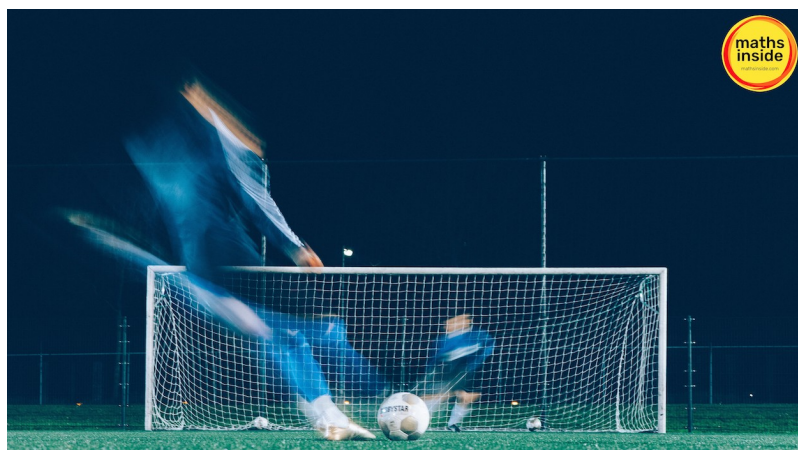
This was a good start, but I wanted to talk more about the maths of the shootout. This made me wonder, how many options do the players have? I can count two: left or right. When the striker goes left, the goalkeeper will try to go left too, but when the goalkeeper goes left first, the striker will try to go right. So, the important thing for the striker is to choose a different option to the goalkeeper, and

the important thing for the goalkeeper is to choose the same option as the striker. I added this into my commentary:

> "The striker is trying to score a goal and the goalkeeper is trying to stop the striker from scoring a goal. There are two options when taking a penalty: left or right. A successful striker will have gone a different way to the goalkeeper, but a successful goalkeeper will have gone the same way as the striker."

I then thought some more about what side a player should choose. What should the goalkeeper do when the striker looks left as she runs in? The goalkeeper should go left, yeah? But maybe the striker is being sneaky and looking left before shooting right.

How should the players respond when there have already been penalties in the game? When the goalkeeper dives right the first time, will they dive right again? What about when they dive right the first two times, or the first three times? This is where I realised the players need to use the maths inside the penalty shootout to work out which is the best option. When the striker thinks the chance of the goalkeeper going left is higher than the chance of the goalkeeper going right, then they should shoot right. When the striker thinks the chance of the goalkeeper going right is higher than the chance of the goalkeeper going left, then they should shoot right.

I put this into my commentary to make it even better:

> "The striker is trying to score a goal and the goalkeeper is trying to stop the striker from scoring a goal. There are two options when taking a penalty: left or right. A successful striker will have gone a different way to the goalkeeper, but a successful goalkeeper will have gone the same way as the striker. It is important for each player to work out which way their opponent will go, so they try to find clues, like which way the striker is looking, or which way the goalkeeper dived on the last penalty, to decide what option gives them the best chance of scoring."

I realised there was more to a penalty than just the direction though. How hard should the striker kick the ball? How close to the corner should the striker aim?

The amazing thing is that these questions can also be answered by thinking about the maths inside! When the striker shoots too softly, what happens? The goalkeeper will easily save it! When the striker shoots too hard, what happens? They might miss the goal. I thought to myself that this means the striker needs to work out the power that gives them the best balance between speed and accuracy. What other choices can the striker make? It's the same thinking for how close they should aim to the corner. Aim too far away and the goalkeeper has more chance of saving it but aim too close and there's more chance of missing the goal entirely!

This meant I could add more information and get the final version of my commentary:

> The striker is trying to score a goal and the goalkeeper is trying to stop the striker from scoring a goal. There are two options when taking a penalty: left or right. A successful striker will have gone a different way to the goalkeeper, but a successful goalkeeper will have gone the same way as the striker. It is important for each player to work out which way the opponent will go, so they try to find clues, like which way the striker is looking, or which way the goalkeeper dived on the last penalty, to decide what option gives them the best chance of scoring.
>
> The striker also needs to work out the power that gives them the best balance between speed and accuracy. Too soft and the goalkeeper has more chance of saving it, but too hard and they might miss getting the ball in the net!
>
> The maths of chance is really important for helping the players win the shootout, and the player that works out the other player's plan best is the one who will win.'

I also came up with a new title:

> "Goal?"

This uses a question mark to show that the players don't know if the goal will be scored, and they are trying to give themselves the best possible chance of winning. Finally, I added the maths inside sticker to my photo and I was ready to submit to the competition!

further things to think about

I can think of so many more questions! What about shooting straight down the middle? Can the goalkeeper wait to see which way the striker will shoot? Can the goalkeeper bluff to pretend they will go a certain way? What questions do you have?

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 photo above is credited to Jannes Glas.