Activity 2: Passing the ball - Teachers' notes

OVERVIEW

In this activity, the team coach invites pupils to analyse what makes a good pass and a successful interception. To help pupils formulate their ideas, there's a video showing two players passing the ball to each other while a defender tries to intercept the pass.

During this activity the pupils should:

- Review a few video clips of passing and interceptions
- Have a class discussion about the possible variables involved
- Review all of the video clips systematically and work on a specific problem in more detail.
- Complete their report for the team coach
- Report back to the class

National Curriculum levels

This activity is aimed at those working at NC levels 4 to 6 and beyond.

Before the activity:

Preview the activity and the teachers' notes and print out the necessary pupil handouts.

Organise pupils' access to the software on PCs and teacher access via a digital projector and speakers. There is actuality sound on the video clips the pupils access during the activity, though it's not essential. However, pupils will need sound if they want to replay the team coach's introductory video clips for themselves.

Decide which elements of the activity will be 'whole class' and how the pupils will work in small groups (suggestion of groups of 2-3 pupils around each computer).

During the activity:

Show the class the football coach's introductory video for the whole case study.
[This can be skipped if the class is familiar with this introduction from a previous activity.]

"Hello! I'm Joe Bailey, the coach of Swanscombe Tigers football club, and you're going use mathematics to analyse the performance of my team. In these activities I want you to look at how they train, how they pass the ball and how they score goals! So choose a topic and report back to me with what you find out."

Select the activity to be investigated.

Show the class the football coach's introductory video for this activity.

"Passing the ball is very important. Accurate passing helps us keep possession and build up attacking moves and get past defenders, while good positioning makes it easier for us to disrupt our opponents' passing moves. So I want you to look at some video clips of my players passing the ball, and think about the angles, speeds and distances involved. Then I want you to come up with some ideas about what makes a successful pass - and a successful interception."

Start pupils working on the activity and provide support to groups and individuals.

Organise the whole class plenary for pupils to evaluate and feedback on their work at the end of the activity.

After the activity:

Consider whether there are opportunities for pupils to replicate the passing activity for themselves, such as in PE or in other sports, where they can analyse further the mathematical variables involved.

Supporting documentation for teachers

- **Teachers' Notes:** An overview of the activity and a more detailed suggested lesson plan.
- **Extension ideas:** Suggestions for further work using the same video content

Supporting documentation for pupils

- **Pupil Problem Sheet:** Screen shots of a particular ball-passing scenario to analyse in more detail
- **Pupil Report Sheet:** For pupils to report back to the team coach with ideas about successful passes and interceptions

Resources required

- A computer and projector with speakers for the teacher (essential)
- A computer for each group of 2 or 3 pupils (recommended)
…with speakers or headphones (optional)
- A copy of the *Pupil Problem Sheet* per group (essential)
- A copy of the *Pupil Report Sheet* per group (recommended)

LESSON PLAN

Start of the lesson (5-10 minutes)

After playing the team coach's introductory video, establish that the pupils understand the task they've been set - to decide what makes a successful pass and interception.

Show a few sample passes from the video and ask the class for their initial thoughts, taking feedback from one or two pupils to stimulate their thinking.

Point out the time-clock in the corner and demonstrate how pupils can play the video frame by frame. Also show the on-screen 'line' and 'dot' tools, which pupils might want to use, though avoid at this stage giving specific instructions as to how to use them in the task.

Ask pupils to watch the clips themselves and jot down as many factors as they can think of that might contribute to successful passes and interceptions.

Pupils' initial exploration & feedback (15-20 minutes)

Pupils work in groups of two or three to watch the passing videos and come up with their ideas. In the video, the passing players are standing about 10 metres apart and there are about twenty separate passes, some fast and others slow. The intercepting player starts in several different positions and intercepts some passes but misses others.

Lead a class discussion about what pupils have noticed and record their thoughts on the board, which might include what variables pupils think are involved, such as distance, speed of ball, angles, position of defender, etc.

Pupils could be encouraged to consider:

<u>2- dimensional shapes:</u>

- The properties of triangles formed by the players
- The mathematical similarities and differences between the different clips
- The shapes formed using appropriate mathematical language.

<u>Units of measure:</u>

- The speed of football kicks
- Which units of measure make most sense in this context
- Convert between units of measure

<u>Compound measures</u>

- The distances and angles involved
- Estimates of distances and times (from the on-screen clock) leading to estimates of the speed of the ball and of the intercepting player
- Ideas about varying speeds and the use of average speed in real-life situations
- How different assumptions about the relative speeds of the ball and the player running affect the outcome.
- The effect of the intercepting player's reaction time, ie the distance the ball will travel before he's had time to move at all. Reaction time is about a quarter of a second, though the intercepting player can to some extent anticipate when the kick will be made.

The on-screen tools are for pupils to use as they choose. The 'dot' tool can be used to mark where the defender began his run for different successful or unsuccessful attempts. The line tool can be used to estimate distances, mark directions or to draw any triangles required. When listening to groups of pupils at work it may be helpful to remind them of these tools, but not to direct the whole class how to use them. Pupils can estimate distances by measuring them off their screens and relating them to the '10 metres' between the two yellow players. They can use 'Print Screen' to save any on-screen image they've created.

Pupils work on a paper based task (15-20 mins)

Note: this is a specific problem to work on for those pupils or classes who require a more structured example. Some groups or classes might be asked a much broader question such as 'Where should a defender stand?' and be left to devise their own values and examples.

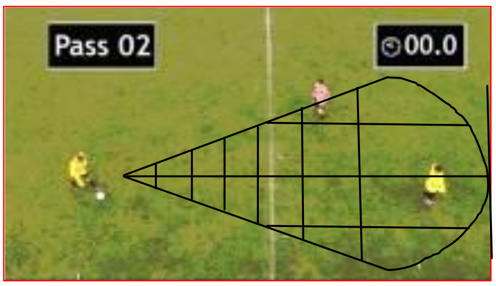
Introduce the specific task on the *Pupil Problem Sheet*. This shows two static players 10 metres apart and assumes that player A kicks the ball towards player B at 20 metres per second. If these factors remain constant, where are the best places for the defender to stand and run to in order to just intercept the pass?

The two screen shots show the initial set up and the defender just making a successful interception 0.7 of a second later. Pupils are asked to determine whether this is a likely outcome. They still have access to the video clips so they can refer to real life examples to clarify their thinking and make estimates of distances and calculate running speeds, etc.

Pupils may need supporting to understanding the relationship between speed, time and distance, which is the main factor in this activity. Thus, the intercepting player has the same time as the ball travels to intercept it. He is unlikely to be able to move at the same speed, which will determine the relative distances involved.

Pupils might suggest that the nearer the defender is to the receiving player, the further away he can stand from the line between him and the passing player. They might even work out that the locus of the places where the intercepting player could stand and just intercept the ball is the hypotenuse of the triangle with its apex at the kicking player. But that is only one special case answer, and pupils should be encouraged to think further.

- What if the defender came at it from the other side? *(mirror image line)*
- What is the locus of all the possible places the defender could stand and intercept the ball? *(he could stand closer than the 'just intercepting' position, so the locus would be the whole area within the two mirror hypotenuses)*
- Can the defending player stand behind the receiving player and still intercept? *(potentially yes – as the complete locus would include an extra semi-circular area to make an 'ice cream cornet' shape)*
- Would the shape of the locus area for the intercepting player vary with the speed of the pass? If so, how? *(the faster the pass, the narrower the 'cornet')*
- What is the effect the defender's reaction time? *(the apex of the triangles/cornet would be some distance in front of the kicking player – what distance? If the defender is too close to the kicking player, the ball will pass him before he's had chance to move.)*



Suggested locus of an area where the defender can stand and intercept the ball.

At some point in this activity you may wish to run the coach's 'reminder' video.

"Now you've got all the information you need, it's time to report back to me with your ideas about what makes a successful pass - and a successful interception."

Plenary (10-15 minutes)

Get the groups to feed back their responses and justification.

Have a discussion about any difficulties pupils encountered using real data and how confident they are about the decisions they have made would be useful to help pupils understand the limitations of their work. Also, what they might have gone on to investigate if they had more time.

Possible responses on the report are:

For a successful pass:

- The pass should go directly to the team mate
- The faster the pass, the less likely the defender is to intercept it.
- The more you take the defender by surprise, the less likely they are to intercept the pass.
- The nearer the intercepting defender is to your team mate, the more likely he is to intercept the pass.

For a successful interception:

- The more the defender can anticipate the pass, the more likely he is to intercept it.
- Don't run towards the ball but towards where you reckon the ball is going to be when you meet it.
- If you can only run at the same speed as the ball or slower, the shortest route to the ball is perpendicular to a line drawn between the passing and receiving player.
- If the defender can run faster than the ball is passed then sometimes running at an angle more towards the ball could be successful.

Mathematics involved:

- Similar triangles
- Loci
- Speed, distance and time
- Angles

Pupils might well mention that this model is flawed because in a real game of football, the players will often be moving at the same time as passing the ball. If this comes up, encourage pupils to formulate new hypotheses about what makes a successful pass in those circumstances – for example, the need to pass ahead of a running team mate so they can 'run onto the ball' – but how far ahead and what new variables come into play *(the speed of running, the distance between the players?).* It's likely that 'non-mathematical' pupils who play or watch football will be aware of these factors intuitively, which could present opportunities to involve them in the mathematics of the situation.

KEY PROCESSES AND CONTENT

Processes relevant to this activity are highlighted

Curriculum opportunities

During the key stage pupils should be offered the following opportunities, which are integral to their learning and enhance their engagement with the concepts, processes and content of the subject.

The curriculum should provide opportunities for pupils to:

- work on sequences of tasks that involve using the same mathematics in increasingly difficult or unfamiliar contexts, or increasingly demanding mathematics in similar contexts
- work on open and closed tasks in a variety of real and abstract contexts that allow pupils to select the mathematics to use
- work on problems that arise in other subjects and in contexts beyond the school
- work on tasks that bring together different aspects of mathematical content, involving use of several of the key processes, or require using the handling data cycle
- work collaboratively as well as independently to solve mathematical problems in a range of contexts, evaluating their own and others' work and responding constructively
- use a variety of resources when solving problems or carrying out mathematical procedures.

Key processes

Representing

Pupils should be able to:

- identify the mathematical aspects of the situation or problem
- choose between representations
- simplify the situation or problem in order to represent it mathematically using appropriate variables, symbols, diagrams and models
- select mathematical information, methods and tools to use.

Analysing

Use mathematical reasoning

Pupils should be able to:

- make connections within mathematics
- use knowledge of related problems
- visualise and work with dynamic images
- look for and examine patterns and classify
- make and begin to justify conjectures and generalisations, considering special cases and counter examples
- explore the effects of varying values and look for invariance
- take account of feedback and learn from mistakes
- work logically towards results and solutions, recognising the impact of constraints and assumptions
- appreciate that there are a number of different techniques that can be used to analyse a situation
- reason inductively and deduce

Use appropriate mathematical procedures

Pupils should be able to:

- make accurate mathematical diagrams, graphs and constructions on paper and on screen
- calculate accurately, using a calculator when appropriate
- manipulate numbers, algebraic expressions and equations and apply routine algorithms
- use accurate notation, including correct syntax when using ICT
- record methods, solutions and conclusions
- estimate, approximate and check working.

Interpreting and evaluating

Pupils should be able to:

- form convincing arguments based on findings and make general statements

• consider the assumptions made and the appropriateness and accuracy of results and conclusions

• be aware of strength of empirical evidence and appreciate the difference between evidence and proof

• look at data to find patterns and exceptions

• relate findings to the original context, identifying whether they support or refute conjectures

• engage with someone else's mathematical reasoning in the context of a problem or particular situation

• consider whether alternative strategies may have helped or been better.

Communicating and reflecting

Pupils should be able to:

• communicate findings in a range of forms

• engage in mathematical discussion of results

• consider the elegance and efficiency of alternative solutions

• look for equivalence in relation to both the different approaches to the problem and different problems with similar structures

• make connections between the current situation and outcomes, and ones they have met before.

Curriculum content

Number and algebra

• rational numbers and their different representations

• rules of arithmetic applied to calculations and manipulations with rational numbers

• applications of ratio and proportion

• accuracy and rounding

• algebraic expressions, formulae, equations, inequalities and identities including index notation and the use of brackets to indicate precedence

• simultaneous linear equations in algebraic and graphical forms

• sequences, including those arising from rules, in a variety of contexts

• graphs of polynomial functions and their properties

Geometry and measures

• properties of 2D and 3D shapes and their applications, including constructions, loci and bearings, deductive reasoning and Pythagoras' theorem

• transformations, similarity and congruence including the use of scale

• points, lines and shapes in 2D coordinate systems

• units, compound measures and conversions

• perimeters, areas, surface areas and volumes

Statistics

• presentation and analysis of grouped and ungrouped data including time series and lines of best fit

• measures of central tendency and spread

• experimental and theoretical probabilities including those based on equally likely outcomes

• applying statistics to enable comparisons.