Bouncing balls: a simple and fun activity to introduce scientific ideas and to practise mathematical skills in the early years

Andy Markwick and **Jenny Hayward**

report on how using children's natural urges to play offered opportunities for them to think scientifically and mathematically

Figure 1 The range of balls used in the activity

Thinking about learning in EYFS

Early Years Foundation Stage (EYFS, ages 0–5) education is arguably the most critical stage in a child's emotional, social and cognitive development, and, as such, the learning must provide children with a range of opportunities to make sense of their world (Larimore, 2020). A learning environment that allows creativity, critical thinking and empathy through collaboration to flourish is one of the hallmarks of effective provision (Beghetto, 2013).

In English schools, effective provision is guided by the EYFS framework (DfE, 2024), which is divided into the prime 'areas of learning', *Personal, social and emotional development, Communication and language* and *Physical development*, and the specific areas of *Literacy, Mathematics, Understanding the world* and *Expressive arts and design*. This complex network of learning exemplifies the cross-curricular identity of EYFS learning. This complexity is deepened by the presence of the 'characteristics of effective learning' (COE), *Playing and exploring, Active learning* and *Creating and thinking critically* (DfE, 2024), which define the learning behaviours that shape the pedagogical approaches to early-years teaching.

The prime areas are important as they form the foundations for further learning. *Self-regulation* is a developmental thread in the *Personal, social and emotional development* strand and it is an early learning goal. It can be understood as the ability of children to manage their behaviour and learning. Opportunities for children to explore and develop these skills must begin in the early years. When effectively encouraged, they can positively impact problem-solving skills, pre-reading skills and early maths skills (Muijs and Bokhove, 2020).

In the EYFS framework, science falls under the banner of *Understanding the world*. Analysing COE reveals a close connection with 'working scientifically' skills, the key stage 1 and 2 strands of the national curriculum in England that define scientific process and enquiry skills through which science knowledge is learned. Therefore, science permeates every area of learning in the early years (Earle, 2022), and it follows that there is an assortment of potential opportunities to develop scientific thinking in younger children.

EYFS and pedagogies for learning

Research on early-years science identifies various routes to promoting enquiry through play. For example, the

EYFS ● **COE pedagogy** ● **Science** ● **Mathematics** ● **Play**

European project, *Creative Little Scientists* (Cremin *et al.*, 2015: 415), established that '*playful experiences*' and '*hands-on, minds-on exploratory engagement*' were critical for scientific development. Pyle and Danniels (2017) urge teachers to move away from seeing 'play' and 'learning' as unrelated constructs and to take on the idea of a continuum of child-directed to adult-directed play, with openings for learning at each stage, whether child-led or adult-initiated. Fleer (2022) discusses the idea of starting with the scientific concept rather than using children's play as a learning entry point. An interesting Scottish study is presented by Conor (2022), who looked at the potential for using stories as an impetus to engage children with enquiry in science. This is also supported by Markwick (2021), who developed a series of exemplar story-led enquiry activities for ages 3–7. However, while guidance exists on developing communication and language through science, there is a paucity of research on the potential that scientific enquiry offers to develop collaboration and self-regulation across the early-years foundation stage.

An activity developed from play

Below, we report on how a learning activity for children develops from play. Children enjoy playing with balls, and such play can encourage collaboration through sharing. However, as with all activities, it is important to consider what might be learned through such play and whether guidance might enhance learning. We wanted to determine whether children could understand comparative thinking and develop their numeracy skills through an enquiry-led pedagogy. We also wanted to see how children's metacognition and self-regulation developed from nursery to reception-aged children.

Introductory demonstration

The activity was introduced separately to a nursery group (ages 3–4) and to a reception group (ages 4–5). We wanted to see whether one year in the development of children, that is, from nursery to reception, influenced how they conceptualised the problems presented to them.

Children were shown several different balls (Figure 1). The teacher picked up one ball and asked, '*What will happen if I drop this ball?*' Responses from nursery children included '*It will hit the ground*', whereas reception children were able to provide more detail. For example, one child stated '*It will bounce*'.

The children were then asked '*Which ball do you think is the bounciest?*' followed by '*Why do you think that?*' Nursery children quickly decided that the largest ball would be the bounciest, but they could not provide a reason apart from '*It's the biggest*'. Reception children also confidently chose one of balls as the bounciest ball; when asked why they had decided on this ball, one child stated '*It is firmer and so will bounce more*'. Others generally acknowledged that this was a sensible response.

The next problem for children to consider was whether a large or small ball would bounce higher. In this demonstration, the teacher held two balls at the same height above the ground and asked '*Which ball do you think will bounce higher?*' Both nursery and reception children thought it would be the larger ball. In this case, it was. However, the teacher then held up another two balls, one larger than the other but very soft. The same question was asked. Nursery children were split in their decision: some thought it would be the larger ball again, and others thought it would be the smaller one. However, they could not give a reason for their decisions. This was quite different for the reception children: almost immediately there was a consensus that the small ball would be the bounciest because the larger ball was soft. One child summarised this as '*The large ball will not bounce; it's too soft*'.

Hands-on investigations

Children were asked to choose two of the balls and find out which one was the bounciest. The nursery child in Figure 2 concentrated while she dropped the balls simultaneously and then attempted to count the bounces. Another child threw the balls out in front of him and attempted to count the bounces but found this too challenging because he threw the balls in different directions. The reception group adopted a more systematic approach, with each child taking one ball, dropping it and counting the bounces and then swapping. One child was excited to report that they had counted different numbers of bounces for their two different balls (Figure 3).

A critical difference between the two groups was the range of self-regulation capabilities. With the younger group, there was some tension around the choice of balls to test, and, for a few moments, this took over their thinking. For example, one child had to manage their disappointment in not getting the blue plastic football. Children found it difficult to focus on more than one request at a time and, indeed, were far more focused on rolling, throwing and kicking the balls than comparing them. The reception children were 'matter of fact' in their attitudes to the question presented to them and showed considerably more ability to collaborate with each other. The older children were also able to conceptualise the idea of comparing and found unique ways of doing this. They either counted bounces or compared the height of the bounces, from the same drop height.

Structuring the activity

Following the initial activity with the nursery children, we decided to include the bouncy ball investigation as

Figure 2 Dropping balls from the same height and counting bounces

Figure 3 This very engaged nursery child reported: '*I got 3 and 7, the one that got to 7 is the bounciest*'

part of our weekly physical education lesson and to provide greater structure to the activity. This time, in pairs, the children were given a hoop in which they placed two different-sized balls (Figure 4). The hoop provided a base for the children to work from and, on a practical level, prevented the balls from rolling around the hall. The activity aimed to determine through child observation which of the two balls was the 'bounciest'. The teacher then demonstrated how to carry out the activity, and each pair had to take turns dropping the ball and counting the bounces. The other child had to retrieve the ball. These roles were interchangeable and presented to the children as 'bouncer' and 'fetcher'.

Figure 4 The structured activity with hoops in a PE lesson

We noticed that structuring this investigation with a step-by-step set of instructions enabled the children to communicate their results and findings more effectively than in the first investigation. This enabled the younger children to build up a conceptual model of the activity and so better understand its purpose. This was not required for reception children, who appeared to already have the cognitive and linguistic agility to make sense of the activity and even create their own methods for measuring comparative bounciness.

Conclusions

- Although it is difficult to generalise with such small numbers of children, for this study there was a distinct difference in the way children were able to draw on their experiences to explain their answers.
- The activity provided a great opportunity for children to practise and demonstrate their counting skills and begin to develop a conceptual understanding of measurement.
- Both nursery and reception children were able to confidently count bounces.
- Nursery children were unable to make sense of comparative measurements without additional scaffolding and practice, whereas reception children were confident in comparative measurement.
- Very significant improvement was seen in children's language acquisition, cognitive abilities and self-regulation (social and emotional) in just one year.
- The activities supported children's scientific and mathematical understanding in a fun way.

All the evidence regarding maths mastery points to looking for meaningful contexts in which to foster mathematical understanding and this simple activity seems to be very effective in achieving this. It is important, however, to recognise that effective learning does need careful planning, especially in the EYFS where children's experiences are embryonic. Teachers must make choices about what approaches work best for their cohort and context.

We need to build on children's natural urges to play, and offer opportunities for them to think scientifically (and mathematically) through collaborative play, without destroying the play itself.

Andy Markwick and **Jenny Hayward** are lecturers at the Institute of Education, UCL.
Email: andy.markwick@ucl.ac.uk; jenny.hayward@ucl.ac.uk

References

Beghetto, R. (2013) Expect the unexpected: teaching for creativity in the micromoments. In *Teaching creatively and teaching creativity*, ed. Gregerson, M., Kaufman, J. and Snyder, H. pp. 133–148. New York: Springer.

Conor, N. (2022) Science through stories. *Journal of Emergent Science*, **22**, 38–42.

Cremin, T., Glauert, E., Craft, A., Compton, A. and Stylianidou, F. (2015) Creative Little Scientists: exploring pedagogical synergies between inquiry-based and creative approaches in early years science. *Education* 3–13, **43**(4), 404–419.

Department for Education (DfE) (2024) *Early years foundation stage statutory framework for group and school-based providers: Setting the standards for learning, development and care for children from birth to five.* https://assets.publishing.service.gov.uk/media/670fa42a30536cb92748328f/EYFS_statutory_framework_for_group_and_school_-_based_providers.pdf

Earle, S. (2022) Early science research summary: use of play and role of the adult. *Journal of Emergent Science*, **22**, 5–12.

Fleer, M. (2022) Balancing play and science learning – developing children's scientific learning in the classroom through imaginary play. *Journal of Emergent Science*, **22**, 13–21.

Larimore, R. (2020) Preschool science education: a vision for the future. *Early Childhood Education Journal*, **48**(6), 703–714.

Markwick, A. (2021) *Science investigations through stories: a blended approach with maths and English*. Hatfield: ASE/Millgate House.

Muijs, D. and Bokhove, C. (2020) *Metacognition and self-regulation: evidence review*. London: EEF.

Pyle, A. and Danniels, E. (2017) A continuum of play-based learning: the role of the teacher in play-based pedagogy and the fear of hijacking play. *Early Education and Development*, **28**(3), 274–289.