What can Play contribute to Early Years Science?

We know that children love to play; an intrinsic developmental vehicle by which children develop a plethora of skills through physical play, playing with objects, pretence and game play. This 'knowledge' of the importance of play has gained the attention of developmental and educational research, with growing empirical evidence for the positive impact that play has on a child's holistic development.

Traditionally play hasn't particularly found a place in schools, and the Early Years programme is perhaps the only time in formal schooling in which play is considered to have a place in the classroom. Indeed the Early Years Foundation Stage (EYFS) framework focuses on skills as opposed to curriculum outcomes that we believe from our current research, to be an influencing limitation to implementing play (with subsequent age groups).

Within the PEDaL (Play in Education Development and Learning) research centre at the University of Cambridge, sponsored by the Lego Foundation, our current research focuses on the role of play in school. What follows is a description of the experiences of two Reception teachers involved with our most recent work.

An introduction to the project might be useful here: very much involved as co-researchers in this early phase of our project, eight teachers across Reception and Year 1 from the Cambridgeshire area worked collaboratively with researchers to explore play-inspired pedagogical practices in their classrooms. The emphasis was focused on child-lead, discovery learning in science. Through on-going data analyses we have identified certain inputs (pedagogical strategies), psychological mechanisms, target child behaviours, and eventual outcomes resulting in a Theory of Change. A tabled representation of this theory of change can be seen below:

Input ➡	Psychological Mechanisms ➡	Target child behaviours ➡	Outcomes
Group work Playful activities Open-ended Collaborative	Exploration Question-asking Growth mindset Executive functions Theory of Mind	Acting on curiosity Motivation & persistence Considering multiple perspectives	Flexible problem-solving Autonomy Confidence Child-led learning

As the baseball coach Yogi Berra said, ''in theory there is no difference between theory and practice. In practice, there is''. So let us consider a practical example in which two Reception teachers implemented a task that they had co-planned. This example comes from a stage of the project in which teachers had already explored interest hooks in order to engage and motivate their children, and had then planned open-ended, discovery learning opportunities to promote aspects of self-regulation (cognitive development) such as self-evaluation and inhibition control.

The planned task had roots in the mini-beast topic, in which the class's caterpillars would 'go missing'. First generating interest, the task was planned in the hope of it leading to active engagement and motivation from the children to solve the problem of where the caterpillars may have gone.

Teachers Kate and Susan (of 6 years and 3 years teaching experience respectively) approached this task very differently. First of all we will describe the events in each classroom with respect to the Theory of Change as above, and then discuss differences in relation to the role of play in school.

Kate introduced the issue of the missing caterpillars to her class, then asked them to draw a map, including accessible outside space of where they thought the caterpillars could go. The teacher liked this task: it allowed each student to be questioned on his or her decision-making. Some children first thought that they may be in the toilets, and upon being asked why, they explained that maybe the caterpillar was thirsty, and the toilets were the closest source of water. The teacher then opened this explanation up to ask the children if they thought that caterpillars needed to drink, which she explains as a wonderful tangent.

Another child pondered if they would be in the year-three classroom, and when questioned, explained that they had been looking at leaves, so perhaps the caterpillars were hungry. This opportunity for children to consider an open-ended task, using their prior knowledge to reason and rationale their thoughts gives children the opportunity to engage in psychological mechanisms such as theory of mind: what would the caterpillar do? What does the caterpillar need? Kate found the ability of the children to explain their thoughts unexpected and exemplifies possible practitioner-learning occurring alongside.

Given the freedom, many of the children continued to look for the caterpillars all afternoon, which highlighted some conceptual misconceptions, one child related hibernating to hiding which the teacher as able to act on.

We also found that the children were independently following their maps, illustrating autonomy from the teacher, and were seen to be displaying self-regulatory behaviour in terms of following the path they had drawn, with one child even counting the steps she had made on her map.

Referring this to the theory of change above, this open-ended problem task which embodies playfulness and collaboration is likely to lead to exploration and, in this case, development of growth mindset: the children were not deterred by being unsuccessful in finding their caterpillars in the first place they looked, they persevered and kept looking according to the plan they had made. When reflecting on this task, Kate questioned how the outcome may have been different if she had made a map and distributed it to the class, would they have had the same resilience to keep looking?

In comparison, Susan told her class that one caterpillar was missing, and allowed the children freedom to find it.

Some children, working collaboratively in self-formed small groups, started to think about places that it could crawl inside or outside. They thought the caterpillar might like to be hot because it would want to make a cocoon. With the same rationale they considered other warm places: the milk corner with the cushions, or the sand pit. In similar fashion to the other class, the interests in the task led the children to use prior knowledge and hypothesise where they might find the lost caterpillar, which we believe to be an act on their curiosity.

Executive functions can be thought of as one of three characteristics of independent learning (the other two being self-regulation and metacognition) and are crucial for goal-directed behaviours. In a classroom, a child demonstrating his or her executive functions may be seen to be keeping track of time, knowing where to gather more information or where to look for help to solve a problem, controlling emotions, and following instructions.

In this example above, leaving the method of discovery open to the students likely allowed the implementation of their executive functions: using alternative resources to find out information about the caterpillars, led by the children. One boy used a book to learn that birds eat caterpillars and was shooing birds away, other students looked for holes in leaves as evidence of a caterpillar presence. Some students independently designed a map, used magnifying glasses, or used a tick list from a previous lesson to keep track of where they could look and others built a trap. In all of these various methods, the children were able to make decisions about the resources they needed in order to complete the task.

The varied methods by which children in this class engaged with the task highlight the diverse ways children are thought to direct their own learning. Again, with reference to the theory of change table above, we believe this playful open-ended activity allowed the children to exercise psychological mechanisms that lead to behaviours in which the children considered multiple perspectives and options. They were seen to be persistent in their quest, leading to outcomes which gave the children an opportunity to practice autonomous, confident, flexible problem solving behaviours.

Upon reflection, teachers were able to consider the alternative implementation as detailed by their colleague. While Kate questioned her involvement in giving the children too much direction by instructing them in map-making, she valued the opportunity for the chance to listen to their ideas. Susan saw the significance in this, and commented how she would gather the children together after a period of free exploration in order to share ideas a whole class.

Kate did feel, however, that the task had been closed off when she made the caterpillars reappear, and voiced her concerns about how to keep a topic moving once the children have expressed interest. Alternatively Susan continued with the

scientific approach of problem – hypothesise – plan – explore - evaluate. In a later task in the project timeline she was able to continue the mini beast theme by finding a letter to the caterpillars from another mini-beast. The children were engaged in finding out who the other mini-beast was, which prompted the children to write their own letter, involving question asking and speculation. This continuation of interest and curiosity led the students in a novel direction, all the while developing the necessary skills as outlined in the EYFS framework.

The role of play in a child's development has been found to benefit the holistic view of skills such as those that are creative, cognitive, physical, social and emotional. As seen in context via these two examples however, the practical implementation may lead to differing outcomes. An aspect that both teachers were able to implement was the use of an interest hook to engage and motivate the children; a practice that we believe resulted in child-led exploration via various psychological mechanisms. The individual direction of the progression of the task led to differing outcomes: the continuation of the task by Susan allowed the children to practice further problem solving skills, building on previous experience with greater autonomy.

Play-inspired activities like the ones described here, are likely to help children to become autonomous, flexible problem solvers through the exercising of relevant psychological mechanisms. These functions are not only beneficial for early learning, but can also be considered to be lifelong learning skills in preparation for later educational and employment careers.

As our project advances we aim to continue our development work with the same teachers, as well as extend our stakeholder consultations with a range of teachers, head teachers, children and parents in our research to make further links between the elements of our theory of change.