

INVESTIGATING HOW CHILDREN'S PLAY CAN ENRICH THE EARLY MATHEMATICAL EXPERIENCE
TEFP0903

FINAL REPORT
HELEN WILLIAMS, JANUARY 2010

The aim of this project has been to investigate the potential for teaching and learning mathematics through role or 'context' play in the early and primary school years, and thus its impact on children's and teachers' attitude to mathematics.

In particular:

- To explore the relationship between adult directed and child directed mathematical activity;
- To listen to children's imaginative stories and to use these to develop mathematical thinking;
- To use the three Reggio Emilia principles of **observing** children, **documenting** children's learning and **re-proposing** their thinking.

A definition

We understand 'role – or pretend - play' to be when participants are for periods 'walking in someone else's shoes', either through a scenario based in something that might happen in 'real life'; or through a storyline inspired by a book, tale or fantasy of the children's own. We are aware there are other, perhaps contrasting and more formal, definitions; eg. Rogers , S. & Evans, J. (2007), p155.

If you are interested in role play, you might find aspects of this report helpful. We are not proposing that all mathematics could or should be taught through context or role play; however, one of us (Paula) now tries to contextualise the mathematics she offers her pupils wherever she can. We are hopeful that observations we have made might promote thought and discussion amongst those on a similar journey. We refer you to the work of John Mason (2007) who says effective professional development requires two main strands:

- Do I recognise this issue?
- Can I see (picture) myself doing this?

We have attempted in this report to describe some moments to help readers recognise an issue and in turn, reflect upon their own situation.

Although this project has been with early primary-aged learners we think it contains reference to some 'big ideas' to do with teaching and learning that apply to all age-groups, such as:

- working at learners' 'learning edge';
- needing to watch, listen and take account of, as part-and-parcel of our teaching;
- intervention – When? How? What to say?
- re-playing, reflecting or re-proposing learners' thinking back to them
- pupil engagement and involvement.

Helen's starting point as an educational consultant with a particular interest in the early years, was two-fold:

- 1 how to plan authentic mathematical experiences that young children understand and might want to engage in;

and this statement by Sue Gifford:

- 2 *"I began to conclude that children's role play was concerned with the larger themes of life, like love and power, rather than mundane things like the price of potatoes."* (Gifford, 2005, p2)

We would also like the project to be considered in the context of the following claim by Iram Siraj-Blatchford (2002); that a lack of evidence-based research into play in KS1 is a serious stumbling block to change at national policy level. What might be a clear and demonstrably effective approach to play for 5, 6 and 7 year olds?

Firstly, I will describe the context of our project, I will then describe what we did and consider some findings and outcomes under each of our three objectives in turn. Finally, I will outline what we have learned and draw some overall conclusions. I will not replicate anything that I have already written about this project (go to <https://www.ncetm.org.uk/enquiry/17172> for initial abstract and interim report). This report is best read in conjunction with these papers. We have tried to bear in mind when putting this together, what others might want to read.

Context

This action-research project involved three primary teachers and an educational consultant collaborating to develop practice together, experimenting and exploring what might – or might not – work. Each of the four members of this research group brought different skills, background and interests to the project group. Three are primary teachers in schools in the Falmouth area of Cornwall. Tracey is a R/Y1 teacher at Wendron Primary School, a four-class rural church primary. Alison is a R/Y1 teacher at Constantine Primary School, a four-class village primary. Paula is a Y3/4 teacher at Marlborough Primary School, a seven-class town primary. Helen is a trained primary teacher with an interest and expertise in early years mathematics and 20 years experience in supporting practising teachers' professional development. Helen had met the teachers on separate occasions, and each had expressed an interest in developing their practice regarding role play. Helen managed the group through the project. Quotes taken from our initial project group meeting, in April:

Tracey: It's important to make the tasks relevant to the child. I think that in R and Y1, they don't know they can't do something and keep going until they achieve. As children get older, once it's wrong on paper, it's wrong.

Alison: Children who are falling behind have a chance to catch up through play in the role play area – it's much less threatening.

Paula (on why her school is pursuing role play in KS2) We want children to see the links between 'school maths' and maths with a purpose. There is a realisation that play is powerful, coming from KS1 – I want to teach like this – with the advent of the creative curriculum, at last I can have more freedom.

The project took place over two and a half terms, crossing two academic years. As a result, the composition of all three teachers' classes changed during the project and the age groups making up Paula and Alison's classes changed. Tracey's original reception children stayed with her into the following year as Y1s, Alison began the project with a mixed class of reception and Y1, beginning the new school year with a class of reception children, and Paula's class of Y3 children stayed with her as Y4s. This ended up a serendipitous advantage as we had a larger age spread of children to observe (reception to Y4), we could develop some of our ideas over a longer period, and we were able to observe some considerable development in some children's ability to get the most out of role play mathematically.

	<i>First two terms of project</i>	<i>Last term of project</i>
Tracey	R/Y1	R/Y1 (last year's R)
Alison	R/Y1	R
Paula	Y3	Y4 (last year's Y3)

In addition to this project, Paula was involved with a larger Local Authority working group focussing on exploring role play and mathematics in KS2, and Helen joined the meetings of this group to hear what these teachers were working on and to feed back on the work of our project group.

Helen's role as the organiser and instigator of the project was to develop what we were together, and separately, researching by spending time in each school, with teachers and children. Helen kept research notes, organised and led feedback meetings, met parents to explain the project, liaised between schools and with the project moderator, and most importantly, visited the three classrooms to work with staff and to work with and observe children. Most of Helen's time was spent making detailed observations (written, aural and video) of children engaged in role play of different sorts, and feeding back her reflections on this role play to the staff working daily with the children. She made a number of video recordings of work emanating from the project. The three classroom practitioners kept diaries of observations and thoughts (extracts will be seen below) and made observations, including video recordings, of their children at work. Helen's 28 video recordings are mainly of small groups of children from reception to Y4 involved in an independent mathematics task in the role play area, sometimes with Helen playing alongside. Some are available as part of this report. **Appendix One** attached to this report is an example of an annotated observation made as part of this project (APPENDIX ONE, Marlborough, Y3, June: Observation of 3 children on the role play island; T, C & B).

From April to December, Helen made a total of 23 visits to the three schools, met with her regional co-ordinator twice, the project moderator three times and held termly meetings with all participants.

The cycle for our action research was:

- 1 to identify our area of interest (refined as our three main aims),
- 2 collect some classroom evidence through observation,
- 3 review the evidence together,
- 4 re-visit our area(s) of interest.

We talked extensively during Helen's classroom visits, and when the whole group met (on three occasions) we used these meetings to explore what had changed since the last meeting, what we were doing differently and what we might decide to do next.

Some initial thoughts

This is taken from my research diary, May 5th :

Role play/context play is important in mathematics because...

"There is a danger that mathematics is seen by children as a subject in which they learn about other people's ideas, particularly yours, and that it has little to do with them."

Straker (1993).

Most young children enjoy fantasy play and I want to tap into this enjoyment for their maths work. I want children to be fully involved and engaged in the maths that they do. It would be wonderful if curricula strove to develop in children a sense of full engagement. I believe role play can do this. I have a sense of children being en route to becoming lifelong learners, in order to nurture this, I want them to see maths as 'theirs'.

It is important in order to fully experience maths as something they do, rather than being something that is 'done to' them, or that others do, or that they do quickly to get it over with to get on with something (else) they really want to do.

It is also a chance for them to engage in some mathematical thinking and problem solving in situations that 'make human sense' (Donaldson, 1986) to them.

Aim 1: To explore the relationship between adult-directed and child-directed mathematical activity.

We were interested in examining what we each meant by play, and what we might want to extend from the Foundation Stage into KS1 and 2. Nationally, there is an issue about how much control children have over their learning and what 'child initiated' and 'adult initiated' learning might look like, particularly in the Early Years. Helen was interested in furthering understanding of terms such as these, as well as 'free play' and 'structured play'; and what 'child directed' and 'adult directed' might look like in different classrooms and with different age groups. In addition, 'child-negotiated learning' has been a current focus across one project school, Marlborough and this influenced us, in that it gave permission for Paula to make changes and further validated the changes she was making.

Helen's conjecture is that describing play or activity as 'child initiated' or 'adult initiated' is a red herring. What matters, is who 'directs' the play/activity after it has been initiated. We have noticed that a productive mathematics learning and teaching relationship can develop where there is a degree of co-direction between learner and adult, from R to Y4. See the café example from Wendron at the end of this section, and the sharing fish example from Marlborough under 'Some findings and outcomes'. Co-direction in these examples, involved Helen saying things like: "Would you like me to be the café banker?"; "What if I...?" "Shall I be the fourth person?"

What we did and what we noticed

Marlborough, Y3/4

Paula at Marlborough School, during April 2009 was beginning to ask her Y3 class "What maths would you like to learn and use now that we have this role play area set up?" She was planning her maths around the numeracy strategy, trying to make her role play 'fit' these objectives. Her class were organised into 'role play groups' broadly by mathematical ability and timetabled for one period of 30 minutes per week to play here. They were not given 'free rein', but a task to complete during this time, planned by Paula, related to the mathematics they were expected to 'cover'.

Paula pinpoints a couple of critical incidents during this time. One was a conversation we had after I had been observing her children in her role play desert island, tackling a task – to make three paper fish, "one the same size as your foot, one twice as big and one half as big"

I had noticed that they completed the task, but were really interested in playing at living as one might if shipwrecked together, ie, sleeping, catching and cooking food, looking out for ships, looking after each other, etc. The second critical incident was sent to me as an email:

Paula' email 6th May:

I have been videoing this week - found out something very interesting about me yesterday! After 15 mins of really interesting maths learning, kids came to me to ask what next. In my explanation I changed the task and completely baffled them when actually they were making good progress before then!

These two incidents contributed significantly to Paula re-thinking how to connect the maths role play with her Y3 children's interests, and how to best understand what her children were doing when working independently. Her focus became less on role play for its own sake, and more one of helping her pupils plan, reflect upon and direct their mathematics learning, with her in a listening role.

By the Autumn term, Paula's class (now Y4) having been given the overall topic heading – Egyptians – were being asked at the outset, "What do we know / what do we want to know about the Egyptians? And then, what maths could we be learning and using? Once

again, they wanted to play at *living* in the environment, and so the tasks they listed focussed on food and drink, clothing and likely activities. For example:

- making clothes to wear
- collecting water from the Nile to make 'beer' to drink
- making containers
- mummifying and measuring lengths of linen.





Paula has described the process for a class of children who haven't played in this way since R/Y1, as 'leaping in' with "here's somewhere to play". Later she linked the maths into this theme, the children in more of a listening role. In the beginning, Paula gave them the context and the maths ideas to get them started – she modelled the planning and decision-making process. She described her later role play as having a completely different feel to it, with the children deciding upon, designing and building the area, and structuring and planning the mathematics they want to learn.

Wendron, R/Y1

Tracey was particularly interested in seeing if she could develop the children's self-initiated play, and thus some self-initiated / child-directed - mathematics. The EYFS terminology is of child-initiated play, what happened in Tracey's context was more child-directed. Here is Tracey in November, talking to Helen just before the project had got going and after Helen had been visiting her classroom that term;

"The jury is still out on role play, as the children are not initiating maths for themselves at all. It's brilliant having something to hang the maths on, though. Basing our maths on the role play area has been very successful as a focus for learning creatively about maths."

At this point, they had built a 'King and Queen's counting house'



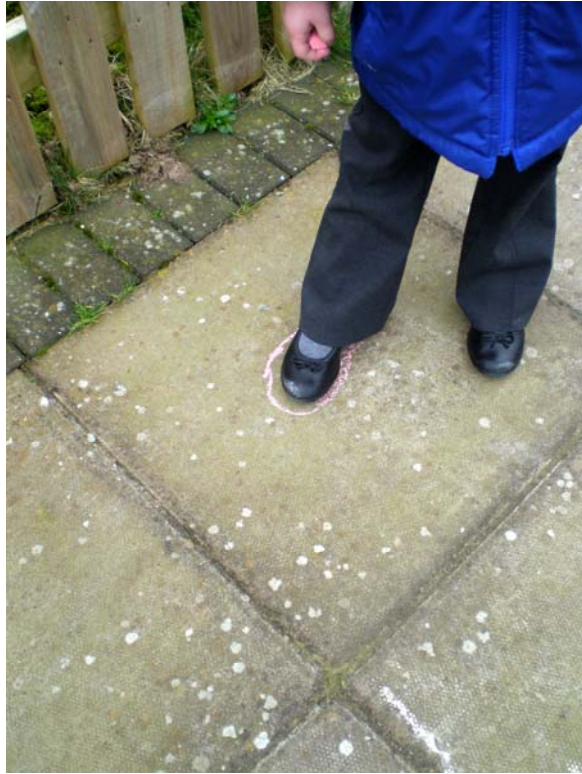


Tracey felt that the adult-initiated role play maths tasks were very successful in engaging her reception children; these included:

- The Queen or King demanding servants collect a (written) amount of money,
- making honey sandwiches, and
- writing and costing shopping lists for the Queen's birthday party.

But that this success, in terms of children replicating or applying these mathematical skills, was not observed in their self-initiated play. When the children were left alone in the counting house/castle without a 'task', the play deteriorated, money was thrown around and no recognisable mathematics took place. The question became, could we change this?

Tracey concentrated on developing related activities away from the area to 'feed into' the play, and on modelling behaviour and roles, and Helen continued to periodically observe the play. The latter fed into the former. In the Spring of 2009, the class role play was a space ship and the children ordered numbers for take-off, collected, sorted and counted moon rocks and compared the sizes of alien's footprints.





Some use of the mathematics skills that were being introduced outside the role play was observed.

By April, Tracey was interested in whether the children's play would develop in complexity as they progressed through Reception and into Y1 (and Y2), and what we as teachers could do to enrich this play. In June, Tracey says she is "starting with her mind in a different place". She is using the role play theme, planned from her class overarching theme and looking how she can approach the necessary content through this theme, relating it to real life examples. For example, weighing and checking in bags for a hot-air balloon flight and costing and selling flight tickets. She planned to do more modelling with her new class; leading onto more verbal problems for them to solve. She

and her Teaching Assistant agreed that the children were playing more, doing less written work and more practical tasks. They noted an increase in the richness of their Y1 children's self-initiated 'free' play and less repetitive, predictable themes, particularly outdoors, compared to other years, and have noted incidents of their spontaneous use of wider mathematical vocabulary, mathematical talk and some simple mathematics being used in wider 'free play' situations, although this is not always directly related to what has been planned or taught. Tracey noticed her children taking some of the ideas and language into their outdoor area, for example; when they build with crates, bricks and tyres, they used comparative mathematical language such as; how long, longer than, long enough, how many people fit inside, etc.

In addition, Tracey's role-play tasks although teacher initiated, have taken account of her children's current interests, as the maths activities she planned outside the role play area reflected what was going on in the children's role play. For example; writing and adding café bills, researching, reading and writing opening and closing times. Tracey's model for her children's mathematics became:

plan some maths linked to the role play theme ...
teach /model math skills ...
use/practice in context ...
debrief.

One consideration that has come out of Tracey's class in particular, is what the teacher (adult) roles might be. We (initiate) set the situation up with some maths in mind (hot air balloon, spaceship...), we consider appropriate props (money, spring balance, learning to countdown...) but we can also play with the children; be a player in the story. This seems to be about *collaborating* in order for some mathematics to happen. Collaborating seen here as co-directing how the activity and the mathematics develops from a given starting point. For example, in April, whilst working with the children in the hot-air balloon scenario, I disagreed that my bag was too heavy to take on board the hot air balloon flight

Constantine, R/Y1

When Helen began to work with Alison at the outset of the project, Alison was asking what she needed to change in her provision and her practice in order for her children to learn more mathematics. Alison too, was interested in how what you plan to 'teach' away from the role play area, together with the resources you provide, affects what happens in that area.

Excerpt from my research diary, 21st May:

Constantine, HW's observation of R spaceship play. I talk to AF about G repeatedly counting up and back from 0-10 using the spaceship 'countdown slider'. He pauses holding the slider on a numeral, looks at C and continues the count when C says. When I observed him playing with E on 6th May, he said: "Now, we have to do the blast off - 4, zero, 10.." then E took over, saying "5,4,3,2,1 zero".

AF is pleased and says this is real progress. She asks if I think that is a result of what she has been doing away from the role play area? (Counting up to and back from 10, children making a sliding 'countdown scale' for the spaceship). I agree - activities as well as resources are impacting on the play.

Here is an extract from Alison's diary, later in the year, with her new Reception class, where she refers to how her observations of her reception children in their first half term, 'feed into' some possible mathematical development.

7th October: Castles - having lunch in the castle.

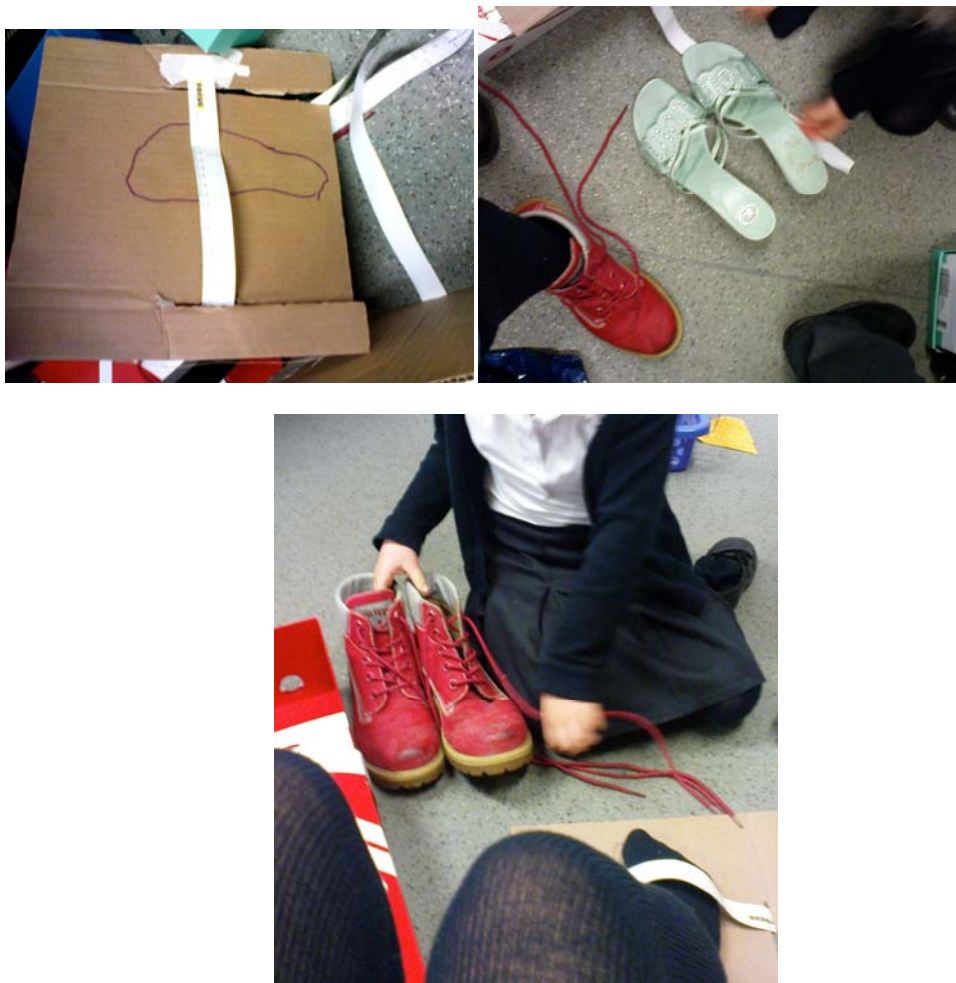
To extend the maths within the role-play I introduced a clipboard and pencil. The 4 children I was working with were dressed in a knight's costume, princesses and a dragon. Each child was given a job to do. First they decided to set the table and make sure there were enough plates for everyone. G wrote the numbers 1-3 forming the correctly but had trouble with 4...(need to put a number line up in the area so she can use it as reference until she is secure in the number shape) the next child wrote down how many pieces of fruit was needed. He said I don't know how to write them (numbers) so I showed him how to make a mark (beginning tallying)... (Need to put marks under the numeral on the number line to represent how many) the third and fourth child copied what the second child had done. The third child (F) could not check his error when recording...(make errors in my counting and model good practice). Will offer this activity tomorrow with number line added and watch what learning takes place and if they use the resources in their play.

9th October

The number line was used by some of the children trying to order the numbers and they used it to count how many plates and cups they needed. Some are starting to record using tally marks as a way of writing numbers. I think I might put a sheet of writing numbers to 4 on the clipboard for the children to write over. They can say numbers to ten but are not secure in what a quantity looks like.

Here, Alison's role play (a castle) is teacher initiated. She uses her observations of her children in directed tasks and in self-directed play, plus her knowledge of the mathematics curriculum to introduce new experiences and new props. In November, I observed children playing outside with Cinderella's carriage, which they had made with me earlier in the week. One child referred to the small playhouse as the 'guard's house', I then introduced a bag of silver discs as tokens for a ride in the carriage and the group of four reception children immediately organised themselves to take turns as guards, kings and princesses, and paying the guard for a ride - and even giving change.





What I found mathematically successful in all three classes was that by using a combination of a partially planned scenario, a judicious introduction of a simple prop (which may be from the 'junk' box), together with observation, and then adult playful involvement, we were able to direct children's attention to something mathematical. For example, in November I sat and watched play in Tracey's café. The teacher preparation to this self-directed play had been to sort through and name the coins in the customers' purses and to discuss the menu and prices. What happened was that the customers had problems finding 8p in their purse of mixed coins ("I haven't got an 8p, what do I do?"). Helen volunteered to be the café banker, who customers or café staff came to for help counting and exchanging coins, and to check bills. The result was several revealing discussions about coins and amounts, with the child leading the conversation and the mathematics.

I liken this process to Marion Bird's description of effective early years' planning as "planning for foreseen possibilities" (1991, p133).

Aim 2: To listen to children's imaginative stories and to use these to develop mathematical thinking.

Observation was our starting point. The basis for our observations was the Reggio Emilia principle of developing learning based on children's 'expressed interests' and Mary Jane Drummond's structure (2003) of looking, listening and noting, then planning some next steps:

- What is there to see?
- How best can we understand what we see?
- How can we put our understandings to good use?

The background to using story-telling as a route for some engaging mathematics was the work of Vivian Gussin Paley (2004) and Helen Bromley (2007), who have found ways to develop and build on children's imaginative, verbal stories to extend children's language and literacy. Helen was interested in this approach as a development of our first aim, as it starts from children's own interests. She wondered if by observing and noting children's play interests we could use these ideas to introduce and work on some mathematical problems. This aim has had limited success, mainly due to the time scale of the project.

What we did and what we noticed





Helen initially made a 'space' story box to use with Tracey's class, intending to listen to stories told by pairs of children and to plan some maths from what was heard. However, this did not happen as planned. Nevertheless, we all began to use periodic observations of the children as a basis to plan some maths. A good example of this in action took place in Alison's spaceship in the second term of the project.

Helen's observations had noted that the children often referred to the spaceship tank 'running out of fuel', triggering an emergency. Alison decided to introduce a simple hand pump to experiment with in the water tray, and then to use this as part of a 'refuelling station' in the outside area for the moon buggy



Here is part of Tracey's email to me on 30th April. At this time her class role play is a hot-air balloon and check-in area:

Exciting stuff today... I let the rest of the Y1s do the same activity (weighing a bag for inclusion on the flight) but I was only able to observe from a distance as I was working with another group. They all seemed to be enjoying it and getting on with it so I called them all together when the others went out for snack, for a chat. They loved it and were telling me all sorts of things. M and B: "After we had been ourselves at the check in we made up names for ourselves and decided where we were going and we wrote that on the stickers too."

J: "I went to Africa and hit a thousand bird flock so I pulled the rope (in the hot air balloon) and went up but I pulled it too much and ended up in space." I asked them if they had enjoyed it and what it felt like when they were doing it - did it feel like work? E replied "No. It felt real". I then talked to them about carrying on with their role play and continuing their stories another time. Somebody (B, I think) said "We know how to start the story now and we can make more up." I said "I wonder what other maths we will find to do in your stories?"

As the project drew to a close, Paula's theme of 'Take one picture' used story-telling to get started. She began by taking the children on an imaginary journey through the chosen picture (St. George and the Dragon, by Uccello), dramatising waking in the walled town, getting up, walking through the gate, etc.

None of these examples really developed children's story-telling in depth, I think we would need more time to develop this strand of our study. However, from what I have observed, I do think that it would be possible to develop children's story-telling to 'travel' to mathematical scenarios - to tell their 'mathematical stories'. Here is an entry from my research diary, 18th June:

I wonder if the story-based problem/tasks such as Paula sets, are possible with younger children? I suspect it is only possible from about 7 years of age (Y2)? Christine referred to the involvement of her G&T children in the burglar story on which a maths task is based. I suggested this is similar to what I am thinking of as role play. It is maths based in a story. But what is different about working with younger children?

What do I think now about this? Why might a story context be powerful? A story knits all the activities together and gives them some reason for being set. Children can behave 'outside themselves' when in an imaginary world, and it may be easier for them to take a risk or answer a difficult question, to make mistakes. This seems to link to Sue Gifford's findings (2005) that young children engage readily correcting a puppet's mistakes, or talking through a puppet. I have found occasionally that if a child says they 'can't do something' it sometimes releases them if I say "OK, *pretend* you can.."

As for using story based problems with younger children (4-6 years), my observations support my theory that a 'maths story' is more likely to be effective if it includes their vocabulary and their ideas.

Aim 3: To use the three Reggio Emilia principles of *observing* children, *documenting* children's learning and *re-proposing* their thinking.

This approach was introduced to us by our external moderator, Christine Mitchell, to structure our observations. It links to Drummond's observation structure (2003). We found it difficult! We used re-proposing as a reflection tool to prompt the development of children's learning.

What we did and what we noticed

Gradually role play observations led to some changes being made to what we were offering the children mathematically. Firstly, the mathematics 'outside' the role play area became more closely linked to the role play 'theme' and what was happening in the role play. Our observations helped us develop some related teaching episodes.

Sometimes these were to teach some mathematics that the children might need in their role play; eg how to read a dial on a spring balance, or count out coins. Sometimes they led from the observed play, eg developing an activity to collect, sort and count out moon rocks, or paying for fuel at a rocket fuel station.

We also considered what interventions we were going to make in terms of additional props or physical stimuli, such as a pay station for Cinderella's carriage, a foot measurer in the shoe shop. This relates to John Mason's 'noticing' methodology (2002), and our conversations stemming from various observations, as well as our diary entries, show plenty of examples of us reflecting on what we have seen and making decisions as a result.

The Reggio structure of observe, document and *re-propose* steps further than this. Adult observers choose and note a short piece of speech overheard from a child, choosing a time to read this back to them for them to enlarge on and investigate further; to re-propose – and this is the hard part! - with no adult interpretation or additional comment.

Y4, Marlborough

As the project ended, Paula said she had found this much more interesting than she anticipated. It was difficult to do, but she learnt a lot about herself and when it would have been more fruitful for her to be quiet. She found some statements did not seem to work as re-proposals, and from these experiences, she went on to develop a plenary linked to the role play and using film to re-propose.

Here is Paula's current interpretation of 're-proposal'. The plan was for pupil review and reflection to drive some pupil-initiated activity. Having reflected upon two terms of role play, and wondering what her learners would have done if they had longer to work on a task, or to re-visit it; from the Autumn term Paula reorganised her timetable so that her Y4 children had longer, uninterrupted time at role play, an initial task planned that could then be revisited or developed over a two week period. She also timetabled a weekly 'role play reflection' slot for the class. In these reflection slots, she began using photographs of observed mathematical activity, or short video clips, as well as written comments from the children for them to reflect upon their learning and suggest developments. She divided the children into two groups, one to look at the maths in the video and the other to look at the learning. With the images as a stimulus, she asked questions like:

- What maths skills did you notice?
- What have you learnt doing this?
- What would you do differently next time?
- What did you notice this group doing that you might think – I could use that idea next time?
- Did you feel this was/you were successful?

As the Autumn term's role play took shape, it seemed that the planning /negotiating/ and agreeing what to do together (as a re-proposal stage) may be critical to maintaining a high level of pupil commitment and involvement. Paula felt the focus on re-proposing, hard though it was to find time for, altered her thinking about how to operate in her classroom.

Re-proposal is hard because we seem to be programmed as teachers to progress through 'curriculum material' at a certain pace, and re-proposal demands time a pause.

It is hard not to re-phrase the question, or to fill the gap! This seems to link to research showing that many teachers use an average wait-time of less than one second after asking a question, and that increasing this 'wait time' to three seconds significantly improves the achievement and attitudes of pupils (reported in Askew and Wiliam, 1995).

Finally: Some findings and outcomes

The main focus of our research was how children's play might enrich their early mathematical experience, with a particular reference to role-play. Our starting premise was that role play is valuable as it allows for mathematical application, creativity, and the possibility of seeing the mathematics in contexts that are connected to young children's interests. We were interested in challenging the assertion that left to their own devices, the youngest children do not engage in mathematics when role playing (Gifford, 2005).

One finding which was particularly notable in the Y3 & 4 classes, was children's high levels of tenacity, involvement in and commitment to working collaboratively on some of the planned 'context' mathematical tasks, even where these were not initiated by the children.

An early example of this resilience was a group of three similar-ability Y3 children on their desert island, attempting to share a 'catch' of 28 fish fairly between them. They appeared quite disorganised and, due to the fact they were sharing 28 between 3 of them, were unsuccessful in finding an answer they all agree with. (The teacher intention had been for them to share 28 between 4, but one group member was away that day, which became a critical element of the task!). Despite –or maybe due to – this unplanned complexity, they stay on task collaboratively for 30 minutes, re-doing the whole and sub-counts several times. I intervene to make it simpler (I remind them to include the fourth group member, and offer to be that person – an offer which is largely ignored) and independently, a satisfactory solution is achieved of 7 fish each if the fourth person is there, and 9 with 1 left over if there are three of them.

It would be interesting to track what influences resilience and engagement further.

Our findings in summary are:

- Children can demonstrate high levels of engagement and resilience in tasks set in a role play context *that they understand and are committed to* – we believe this is of fundamental importance;
- Adult intervention of differing sorts, eg. playing alongside, adding a prop, work outside the area, linked to observations made of children's play can fundamentally affect the amount and depth of mathematics engaged in independently;
- Uninterrupted time – by which we mean some extended time put aside for children to work at one task, although not necessarily at one sitting – can lead to mathematical thinking at a deep level, and children quite happily tackling mathematical ideas outside their usual curriculum 'level';
- Children appear to be willing to take mathematical risks because they are not 'themselves';
- Although it is virtually impossible to predict accurately what will attract deep commitment from children, it is our conjecture that introduction of cognitive dissonance will nearly always work; eg the 27 *didn't* share between 3, my bag was reading as zero weight...;

- Interestingly, the more open-ended the role play scenario (ie. *not* the café or shop) the more mathematical opportunities there are, but be prepared to pick up and run with children's interests even though immediately they might not appear productive (eg. the hot-air balloon, castle and desert island examples);
- Children of all ages can become engrossed and rarely ask for adult help tackling quite hard tasks and once interested or hooked, role play is a useful tool for children to extend and challenge their own learning;
- There is some evidence that maturity plays a part in the youngest children's ability and willingness to 'carry' maths to and from role play scenarios; this would bear further investigation;
- During this project, all three teachers' emphasis and focus of attention moved towards the children as learners, rather than simply the curriculum or teaching as delivery.

As the project drew to a close, Tracey had some reservations about her younger children carrying the mathematical play through to their self-initiated play. Here are some written thoughts in December:

The idea of children importing and using maths in independent role play has not been successful. The children enjoy the role play maths but do not follow it through into their own play. In the days immediately after input with the adult in role the (children) carried it forward independently but there is a quick drop off in interest other than 'playing'. The most successful term was the summer term with Y1 children. Was this because they were more confident with their maths concepts and older? If this is, so then the summer term would be most successful in future.

Here, Tracey acknowledges the changes she has made to the mathematics she offers her children as a result of being involved in the project:

I plan my maths always looking for opportunities to incorporate the role play area, which I didn't do before, I thought of the area more as an area for language development. Even when it is not possible to use the current role play area I am looking for opportunities to use real life situations to practice maths. I will continue to do this in the future as I have found it to be valuable in extending learning experiences.

Paula, too, recognises the teacher role has changed over the time spent on this project; "From providing both the ideas and the focus, to providing a focus for the children to develop their ideas. The teacher provides the materials, time, the practicalities etc." I would argue further, that, as the role play becomes much more interwoven with what else happens, and particularly the mathematics that happens, in the classroom; this has implications for teachers and CPD. Observation is not enough in itself to promote mathematical play, the adult needs to know what (s)he is looking out for (broadly) and where (s)he might take it. Modelling some mathematics requires similar background knowledge of how mathematical processes, skills and knowledge connect. Broadly, a key issue seems to be about adults, as well as learners, being confident enough to become playful with mathematical ideas. It also requires a different way of looking at mathematics and learning about mathematics: mathematics as something to be engaged in and produced by learners rather than a received body of knowledge.

Paula: "Sometimes we just have to set things up for children to learn how to learn about maths, not just to tick boxes."

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