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Young Scientists

Doing Science with Babies, Toddlers and Kids – A Book for Parents

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Acknowledgements:

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And of course to my two gorgeous girls, for experimenting with me and letting me experiment on them. But don't anyone tell them that.

No children were harmed in the making of this book ☺

Front Cover: The big girl is putting out a candle with a syringe and they are watching a candle suffocate like in "Candles and clever girls"

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This book is not aimed at teachers or educators. This book is aimed at parents. Far too many people think that science is hard – by the time you get to highschool or beyond, only the geeks are into it. Yet all babies start off as scientists. At heart science is very simple, it is about asking questions and looking for answers, something little kids do every day. So in reality, this book is about making parents' lives easier by giving them some ideas on guiding those questions and extending them, giving you more to do with your kids that you know will help them.

Why should I do science with my kids?

There are so many reasons!

- **It's what they naturally do.** So rather than having to teach them how to do something new, you're just watching them and helping them a little further along the track they're already on.

- **It keeps you out of the rut.** I've been at home with my kids for over four years and while I love them to bits, there are times it gets boring! But playing with playdough, getting outside, playing in the kitchen or bath – there are so many things you can do. Science gives you a framework to extend any activity, so it's different every time you do it. Plus it keeps them interested for much longer – good for you not having to do so many activities, good for them to develop persistence and concentration.

- **It's fun.** Watching kids can get boring. How much more fun to get in there with them and play as well.

- **It develops higher level and critical thinking skills.** Science is all about questioning and looking for answers, so it makes people, including kids, really think about how things work or put together different ideas. It makes

people look at their answers to see if they really fit with what they can see around them, and keep going until it does. So it's great for creativity, confidence, exploration, imagination, co-operation, visualisation, questioning, observation, curiosity, initiative, risk taking, persistence, memory and self-regulation.

It gives kids a good background to become future citizens. Most of the big issues that will face us and our kids are about science. Climate change, health, genetically modified food, internet based society, participation in the global economy, these are all things that need informed citizens who can think critically. Science can directly inform us on many of them, and can help us develop the skills to think about others.

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Saying Yes – even when you know it will be a disaster

Back before I had children I taught Secondary Science in tiny little schools. My default position on student requests was generally "No," or at least "Let me think about it." And that was a pretty sensible position to take when you consider mixing kids who've barely been to school, let alone science class, with acids, electricity and flames. And it could be argued that it's also a sensible position to take with children under the age of, oh, marriage, because common sense really isn't that common.

Even with the default I taught many memorable lessons, like the time someone knocked over the large beaker of boiling copper sulfate. Or the bang and flash when an innocent student plugged something into the socket another student, luckily not mine, had shoved a paperclip into. Or setting fire to large chunks of steel wool when they were supposed to be investigating fuses (it did break the circuit). Or the time the sodium exploded and molten sodium splatted on the ceiling then

rained down in little flaming droplets. Oh wait, that was me. Putting the scalpel on the wrong way and sticking it into a finger was me too. Hmm.

So it seems I have a certain genetic basis for trepidation when it comes to letting my toddlers loose.

But really, what's the worst that can happen?

Put in the standard disclaimer here, I'm not talking about anything near roads or letting them loose in the medicine cabinet. There are certain things that are just plain dangerous, accidents happen and toddlers really don't have any common sense. But bumps and bruises and stubbed toes are a part of life.

I know that using playdough in the paddling pool is going to be soggy and fairly revolting. They didn't, and they haven't asked to do that one again.

I know that hosing shaving cream off the driveway will make it extremely slippery. They didn't, now they're very careful where they walk.

I know that water colours aren't going to cut it on pretty much anything except paper and YOU ONLY NEED A TINY BIT OF WATER and stickers won't stick on other things once you've put them on your sister's back. They didn't, now they ask for the alternatives.

I know that mixing red and green and blue and orange and that much water with the rice is going to turn into a sludgy brown mess. They didn't, now, actually that one they still do.

Maybe the way we develop common sense isn't by having success. Maybe common sense is really another name for experience. And the experiences we remember seem to be the ones where things didn't really go to plan, because we know next time we have to do it differently.

So the next time your child asks to do something you know is going to be a disaster, don't use the default "No." Take a deep breath, take some basic

precautions (generally here that means outside and stripped off) and say “Sure darling, why don’t we try that?”

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Learning on their own.

The other evening we went outside after dinner and big girl (about to turn 4!) announced she wanted to play the jumping game. After a bit of explanation (you put a rock down and jump on the numbers) we worked out she meant hopscotch.

Fair enough, she had obviously played it with someone else so was capable at some level, so I drew the boxes with chalk and off we went. *As an aside – do not play hopscotch barefoot on concrete. Put decent shoes on.* Now when I was playing hopscotch at school there were all sorts of rules that I knew an almost four year old wouldn’t be able to handle, plus I was interested in what she’d been taught, so I just let her go.

It was hard.

I seriously wanted to tell her the rules, then correct her or at least encourage her to do it ‘properly.’ And I did that quite a few times.

But as we kept playing and I watched her I realised the words were just getting in the way. There were little improvements all the time, and they weren’t the things I was telling her about.

She started picking up the rock then jumping over that square on her way back.

She started putting one foot in each of the 4/5 and 7/8 boxes.

She started jumping to turn at the top.

In other words, I had a vivid and pointed example that little kids don't need to be 'taught', they will learn just by watching you. It's like when she started brushing her teeth and kept putting the toothbrush under the water, I realised I do it. It's like baby girl emptying the potty in the toilet and saying "Yay!" Since having kids I've been shown that I prefer to use a certain cup, open my drinks in a particular way, and put my glasses on first thing in the morning.

We all know about these ones, we've laughed about our toddlers with their hands on their hips telling us we have two choices. We know they copy us. But how often do we think to harness the power of that mimicry and forget telling them what to do, just do it yourself and let them watch and copy.

I have a challenge for you – next time you are doing something new with your child, it could be a craft activity, cooking, sport, anything. Don't tell them what to do. Let them watch and do it with you and see how quickly they pick it up.

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Observation

The place to start with babies and young children is observation, the information we get from our five senses. These are sight, hearing, smell, touch and taste, although don't do taste with very little ones!

Touch – The first sense to be developed. Even newborn babies have a good sense of touch, especially on their face. The rooting and attachment reflexes to help them feed are stimulated by touch on their cheeks and lips. The Moro or startle reflex is in response to falling, the stepping reflex is activated by touch on their feet and they grip with both

their hands and feet. These are all about keeping them alive, but touch becomes their best way of exploring the world for at least the first couple of years. So give them lots of different things to feel! Most of these we do with little babies, but toddlers and even big kids will enjoy them too.

Body –

- Massage.
- Moving newborn limbs to encourage them to uncurl, like gentle baby aerobics.
- Finger games and songs.
- Blowing raspberries.
- Lots of cuddles!
- Carrying in a sling or wrap so they are against your body.
- Covering and uncovering with sheets, muslins or wraps.

Movement – of themselves and other things.

- Blowing on their face, tummy, hands, feet.
- Aeroplane and swinging games.
- Swinging in a hammock or rocking in a chair.
- Rolling on a ball.
- Riding on a wagon or bike.

Texture – rough, smooth, bumpy, sticky, ...

- Texture boards
- Fabric books
- Most baby books and toys.
- Different clothes, rugs and mats.
- Go outside and let them play in the dirt. It really won't kill them.

Temperature –

- Baths and showers.
- Sun and shade outside.
- Rain and mud.
- Iceblocks to suck or hold.

- Lamps, stoves and candles – this is one to be careful with. But it's also something kids need to learn to be safe. Both of my girls developed a sign for 'hot' that looks like holding your hand over something to feel it.

Sight – as primates, our primary sense. Sight develops during pregnancy, babies in utero will react to a torch shone on the bump.

Light/Dark – having a light routine can help little babies – dark at night, light during the day.

- Moving shadows, especially under a tree.
- Following a torch with their eyes or following moving shadows (this can be a lifesaver on night car trips. Always keep a torch in the car.)
- Chasing a shadow for a mobile baby.
- Chasing a spot of light around the floor.
- Crystals or dream catchers.
- Moon Gazing.

Colours

- Little babies see black and white patterns best.
- Red, then bold colours of blue and green develop next.
- Pastels are the last colours to be seen.
- Mobiles can be made from straws or pipecleaners.

Movement

- Tie ribbons or shoelaces onto a handle (spoon, ruler, …) and move them around.
- Have a string across the room and dangle things off it – keys, spools, teething rings, …
- Watching birds or ants will fascinate older babies.
- Watching streams carry leaves or drips off plants. See Jumping in puddles.

Hearing – for speech and communication.

Volume and Pitch –

- Music and radios
- Singing
- Shakers and Rattles
- Going outside – birds, traffic, wind, dogs, people in the distance.

Direction –

- Play sounds in different directions including above them, see if they can look towards it.
- Play sounds while moving around.
- Try to find birds, aeroplanes, cars or dogs when you hear them.

Voices –

- Record voices of family and friends, play them back while looking at photos.
- Reading. Lots and lots of reading.
- Discuss pictures or describe what you're doing. I'm not a talker myself, but you get used to describing your entire day!

Smell – the earliest sense, it's very strongly linked to memories.

- Do you wear a perfume or scented toiletries? They're not recommended with a newborn because they can be too strong and confuse them, especially while breastfeeding is being established. But when they are older kids can strongly identify with the perfume their mother wears regularly.
- Put them close to smell flowers.

- Crush leaves to release the smells, herbs are especially nice.
- Put a couple of drops of essential oil on a favourite teddy or security blanket (test it to see if it fades/stains first).
- Make a special nap pillow with lavender or other herbs or oils in it.
- Have pot pourri or air fresheners around.

Taste – Young babies have far more tastebuds than adults, but they are very strongly focused on sweetness. This makes sense – babies need lots of calories. Breastmilk changes taste depending on the mother's diet, so breastfed babies generally take well to family foods when they are ready. Babies who have been on formula aren't used to lots of different tastes, so they sometimes need more goes to accept different foods. Obviously this isn't one to play with until they're older and onto foods.

- Taste the spice rack.
- Try foods from different countries.
- Involve them in cooking and let them taste the individual ingredients.
- Try a tasting plate blindfolded and see what they can identify.

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Natural scientists

The beginning of science is questioning. Babies and little kids may not verbalise, but they are continually questioning and testing.

Babies are asking **"What happened?"**

- What did I hear?
- What do I see?
- What can I feel?
- What's that I smell?
- What's that new taste?

Older babies and **toddlers** start to ask "**What happens if I?"**

- What happens if I throw this? What happens if I drop this out of my cot? What happens if I drop it from my pram?
- What happens when I smile? What happens if I yell? What happens when I cry?
- What happens if I push this? What happens if I pull this?

Preschoolers and **older kids** start to ask **"Wouldn't it be cool if?"**

- Wouldn't it be cool if I got some of those marbles out? (I didn't say they had common sense)
- Wouldn't it be cool if I poured this paint into the other container?
- Wouldn't it be cool if I got some of those flowers for Mum?

Everything is a teaching opportunity. (OK, some things may be straight disasters, like the baby throwing the card with the bank details on it in the toilet, but you get what I mean).

This may sound like it's a lot of extra work, but in fact it's a good thing, truly an opportunity. This is because one of the hardest things with little kids is filling the days and keeping them occupied, and anything that draws an activity out and extends that attention span is pretty good. It is just a matter of training yourself to notice the opportunities around you and take advantage of them, turning your vision outward rather than inward.

Some examples?

In the shower – Mummy! Your boobs are blue! A very quick explanation of blood circulation and veins - blood carries things we need around our bodies. When it's dropped everything off it turns blue and goes back to pick up more. You can see it looks blue where the blood is moving under my skin.

Why is it raining? The water in the air all sticks together until it gets too heavy for the clouds and falls down.

How did that light get in the tree?! This one took me a while to understand what she was asking, I had to get down on the floor with her before I saw that the room light reflected in the window looked like it was up in a tree. So I gave her a simple explanation of glass acting as a mirror, helped by the mirror on the wall.

Daddy: We're driving over the Todd River.
Toddler: No it's not!
Daddy: Yes, ask Mummy.
Toddler: But there's no water!
When appealed to later, I agreed with Daddy that it was indeed the Todd River. In Alice Springs it is very dry, and the water soaks into the earth and is all underground, which is why lots of trees and plants could grow in the river because they're drinking the water underneath. You only see water on the top when there's been lots and lots of rain.

When I closed my eyes I saw two red spots! It looks like there's a tiger watching me! Luckily this was more excited than scared. Two red spots had me a bit stumped, until I did the obvious and checked the light to see there were two globes. Your brain in your head gets used to things, so it's used to your eyes telling it there are lights there. When you shut your eyes it thinks the lights are still there, so you see the red spots.

So once they can talk there are heaps of cues. But what about before they are asking a million questions?

- At the moment our favourite saying is “Newton was right! Gravity works here too!”

- As I was walking along with my baby I stripped off a few rosemary leaves, crushed them and held them under her nose. I gave them to her and she rolled them, played with them and put them in her mouth (and spat them out pretty quickly, too).

We all spend hours carrying babies around, how often do you stop and point things out to them? Do you point out sounds and let them feel textures and smell things as well?

So here’s a challenge. Just count how many times a day you could encourage your baby to look, listen, touch, smell, taste. How many times a day does your toddler ask a question? When you are regularly getting to a hundred before lunch, you’re noticing the teaching opportunities your children are offering you.

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Turning Anything into a Science Activity

All of these activities are designed to fill in gaps around what your child is already doing. If they are perfectly happy playing, let them! Be aware of the possibilities so you can throw in a gentle nudge if they seem to be slowing down. Or if they've given up playing with the torch because it's boring, you have something else to suggest. Or if they've never cooked, or never been out in the rain, now you have some new ideas. But first allow your kids to use their own innate inventiveness, because they will surprise you.

When I was teaching teenagers and got out the magnets or mirrors or even mathomats, I always allowed at least one lesson to play. Of course it was called discovery learning, or free exploration, or something fancy like that, but really it's about letting them loose and seeing just how creative they are all on their own. And these were teenagers who were too cool for school, just think what enthusiastic little kids can come up with!

Imagination is like anything else – it gets better with practice. And imagination is one of the most important things we can give to our children. Whether it is a science hypothesis, an abstract sculpture, or a new way to earn a living, one of the fundamental skills both for individuals and society is creative thinking. Giving your child some resources and then stepping back can be hard, but it is well worth it.

Suggestions

Even babies only a few months old will look longer at something unexpected. So you can try demonstrating these for your baby, or let your big kids go on their own.

- Give **babies** lots of sensory experiences so they can think "Whoah, what was that?"

- Give **toddlers** lots of interactive experiences so they can do things with the toy or you.
- Give **older kids** guidance and enthusiasm so they can safely try different things.

We're **painting** for the millionth time, so what will happen if we –

- Mix the paints together?
- Use twigs and leaves for paintbrushes?
- Water down the paints?

We're **making playdough**, so what will happen if we –

- Put in some essential oils?
- Put in less water?
- Leave something out?

We're **running around outside**, so what will happen if we –

- Run in circles?
- Run as fast as we can?
- Stop suddenly?

We're **playing with balls**, so what will happen if we –

- Use a different size ball?
- Drop it from a different height?
- Throw it rather than dropping it?

Playing in the **sandpit**, so what will happen if we –

- Add water?
- Compare different sands?
- Dig a wider hole?

There's a **dripping tap**, so what will happen if we –

- Turn the tap a bit faster?
- Drip it from a different height?

We're **growing crystals,** so what will happen if we –

- Use salt instead of sugar?
- Add some food colouring?
- Put in more/less?
- Use hot water?

Playing with a **torch**, so what will happen if we –

- Hold it closer to the ground?
- Shine it on different surfaces?
- Cover it with some cellophane?

The baby is **rattling things,** so what will happen if we –

- Use a different container?
- Use something different inside?
- Shake faster?
- Hit it with something?

Playing with **balloons**, so what will happen if we –

- Blow it up more?
- Blow it up and let it down lots of times?
- Leave it blown up for a few days?
- Put in some water as well?

I have lots of **water containers** in the fridge, so what will happen if we –

- Have different shapes and depths?
- Leave it in the sun?
- Pour water from a height?
- Splash it?

We're blowing **bubbles,** so what will happen if we –

- Put in some food colouring?
- Change the proportions of the bubble mix?
- Use different shaped blowers?
- Blow fast or slow?

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Predict, Observe, Explain

You can turn anything into an experiment by asking questions and changing something. For a bit more of a scaffold, use

Predict, Observe, Explain

Predict:

This is a guess of what will happen, of the form "If ..., then ..." Obviously you can't do this cold. To be able to guess what might happen you have to have experience of similar situations. That's why this is at the end - you need to be comfortable getting your kids to observe and ask questions and do things before you can ask them to predict. But there are some things that even little kids can start to predict:

- If I bang this, then it will make a loud noise.
- If I bang harder, then it will be louder.
- If I knock this off the table, then it will fall on the floor.
- If I bang in the bath, then it will splash.

Older kids should be able to make more complicated predictions:

- If I run faster, then I will get there quicker and be hot and out of breath.
- If I use two magnets together, then they will stick to each other.

Don't forget when you are making predictions to think about all the things that might happen, so something might fall, and bounce, and make a noise, and break.

Observe:

Use all five senses, sight, hearing, taste, touch, smell. It might be fun to record your observations as well:

- Write them in a journal.
- Glue them in, if it's a photo or something like chromatography.
- Draw pictures of them.

- Make a model, especially if it is something to do with earth.
- Make a collage.
- Use the computer, especially if you have video or sound.
- Do a role-play.
- Sewing and embroidery

Explain:

Now there's the trick! This is one I would expect parents to have to step in on, because it is where most of the learning is going to happen for little kids. Let them have a go, but they're not going to be ready to do it on their own until they know a lot more about how the world to fits together.

It's also a judgement call how much they're ready for - I wouldn't explain that things make a noise because they create sound waves that move air molecules that hit your ear drums! Rather I might say that there are different sorts of energy and the movement energy of their banging changed into sound energy. That explanation is a good one because it leads straight to another question: What other sorts of things around here make sound energy? Vacuuming and Musical Instruments are just two examples, there are also cars, animals and running water. So that's a very rich explanation because it leads to lots more things to do.

Most of the time, I would continue with encouraging them to try things and then try something a little bit different. But every now and then it's fun to do something as a planned activity, and Predict, Observe, Explain is a good framework to use.

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Resources

General

- A digital camera. We have a child's one, although the way it goes through batteries means it's fairly useless. They're both quite successful with a real one.
- A tripod. A fantastic safety net for the camera. By setting it up on a tripod at the right height she either doesn't move it around, or if she moves she hits things with the legs rather than the delicate camera.
- Books. I'm sure it doesn't need to be said. And a library card.
- Blankets/wraps. These are incredibly versatile. Portable play space, picnic blanket real or pretend, cubby, put balls on them and roll them around, dress up, keep warm, play hide and seek, cocoon for caterpillars then wings on the butterflies. We have flannel and muslin ones from when they were babies, plus a big bright pink leopard print one that my husband picked out for the big girl. Just hem a large piece of fabric, I cheat and use the rolled hem on the overlocker and it takes about 5 minutes. If you're really creative you can put a casing around the edge and put a cord through, instant toy bag. Or make a fleece quillow – put a big patch pocket on the middle of one end, the blanket folds up and turn it into the pocket and you have a pillow.

Consumables – try an office supplies store or somewhere teachers go. There is such cool stationery out there. Alternatively $2 shops.

- Stickers
- Post cards – These are a big hit with us because we live interstate from most of our family, but you can always send a postcard.
- Balloons
- Water balloons
- Contact – a big piece of contact sticky side out on a kitchen cupboard with lots of bits of paper, pompoms etc that they can stick on it is marvellous entertainment.
- Poster paint
- Fridge magnets – lots of places give out free magnets, kids don't care what it is advertising!
- Sidewalk chalk

- Straws
- Pens, textas, crayons, pencils etc.
- Sticky tape and a dispenser. And if you don't want things stuck on your walls, sticky tape balls are still cool for little ones to play with. Hours (or at least minutes) of entertainment watching a baby trying to put one down.
- Old magazines
- Shaving Cream, lots and lots of shaving cream. This isn't just fun for getting all over yourself and drawing on walls, it can be carefully mixed with the poster paint then used for 3D finger painting.

Toys

- Torches and a good supply of batteries.
- Fit ball – brilliant for babies to bounce, tummy time, push, roll, one of these is a must at any age.
- Cars.
- Balls of all sorts

Kitchen

- Biscuit cutters. These can cut toast, sandwiches, salt dough shapes and playdough as well as the obvious.
- Oatmeal – make up with a bit of boiling water, leave to cool and you have a mud substitute for babies to squish and smear.
- Pasta tubes and shapes. They can be threaded onto pipe cleaners as well as gluing and they make great rattles.
- Overcooked spaghetti. Break them up into little pieces and overcook them, they're a great mud substitute like oatmeal.
- Rice. Can be coloured with food colouring fairly easily
- Playdough
- Wonton wraps. Very easy, and all sorts of things can be cooked up then put in them. My 3 year old can make them herself using ravioli moulds.

Containers

- Any plastic kitchen jars, especially things like stock containers.
- Egg cartons
- Little tiny decor/willow/tupperware containers, including pill and dressing ones.
- Bags, bags and more bags. We have hand bags, shoulder bags, overnight bags, present bags, backpacks, green shopping bags, pouches you name it. They love putting all sorts of things or collections in them and they're great homes for socks, finger puppets or ribbons. Shopping is so much fun when the toddler is carrying it in her butterfly backpack.

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