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The emergence of design ability : the early years

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Abstract
Design and technology is about the way in which we shape our world to meet our needs, bearing in mind that we, too, are shaped by our environment. It is a relatively new addition to the primary curriculum, but is it new to children? We must all have seen young children creating things that did not exist previously, whether from stones, sticks, sand, paper, playdough or in fact any materials or components that might be to hand, as they shape and create their own models of the world. Through the designerly activities of young children we see our culture made manifest. Children see through the eyes of their culture and exhibit a natural curiosity about cultural meaning, the way things are done, how people behave, what things look like and represent. The aim of my current research is to more clearly understand what constitutes the ability to design, or more correctly abilities, and see how these abilities are displayed in the early years. The focus in this research paper is on perceiving, imaging and modelling:

A) Perceiving - learning to see ordinary things and exercise the skill of seeing, for how can we perceive what might be if we cannot perceive what is?

B) Imaging - ‘seeing in our mind’s eye’
   i) what is (but is not before us at the time)
   ii) what was
   iii) what might be

C) Modelling - using symbols to represent things, making one thing stand for another

The following research forms part of a much larger case study undertaken with Joe, who at the outset was 2 years 6 months and is now 4 years old.

A) Perceiving what is
We cannot begin to visualise what might be, if we have no perception of what is, so for part of this research I decided to present Joe with some line drawings of visual schemas that I took to represent certain things a hat, a house, a thin rectangle, a fir tree, a window with curtains, an eye, a circle, a mouth, a triangular tree, a door, a table, traffic lights, a fence etc. I presented these to Joe for the first time, at the age of 3 years 3 months and on a monthly basis thereafter to try and find out whether his perception had changed over time. On the third showing I coloured in those with a defined form, to see whether this affected his perception of them in any way. The question I asked when I presented these to Joe was “What do you think this might be?”

There were two schemas that elicited the same response every time house and chair with no other qualifying remarks. Four other schemas remained the same, road, fence, tree and fork, but with the addition of qualifying remarks, as Joe moved from the general to the particular.

For example,

| Age 3.3 | “Fork” |
| Age 3.4 | “Fork” |
| Age 3.5 | “Fork” |
| Age 3.6 | “Fork to eat dinner” |
| Age 3.7 | “Garden fork” |
| Age 3.8 | “Fork that goes in the fire, with sharp fings that go in the toast” |

What is interesting about Joe’s perceptions is that some of the images he is able to manipulate mentally. The following schema I set down as a bird’s head and beak. With Joe this became, in the main, an icecream.

For example,

| Age 3.3 | “Icecream” |
| Age 3.4 | “Lamp” |
| Age 3.5 | “Icecream” (This schema remained uncoloured at this stage). I asked Joe if this was the right way for icecream to be. He said no, that it would fall off. |
| Age 3.6 | “Icecream” (Again I asked Joe if this was the right way for |
icecream, so he took the card and turned it around.)
Age 3.7 "Icecream, but watch, icecream goes like that" (Again he turns the card around.)
Age 3.8 "When it's like that it's a icecream" (Turns card around). "When it's like that it's a space rocket" (This reference to space rocket indicates Joe's particular mindset at this time. He is heavily influenced by Thunderbirds and Button Moon.)

Another image that indicated Joe's ability to think visually emerged with the following schema.
Age 3.3 “Bin, for putting rubbish in”
Age 3.4 “Cup”
Age 3.5 “Cup” (now coloured green). “There’s a saucer as well” (As he said this, he pointed to the base of the cup where the saucer would have been, so clearly he was able to visualise a saucer being in its usual position).
Age 3.6 “Cup with orange juice in”. (I was perplexed at this answer as the cup was coloured green, so I asked him why the cup was green). “Cos cup’s green. Orange juice is in the cup.” (This indicates that again, Joe is able to visualise and also that he has the ability to ‘read’ my hidden question “Why have you said that orange juice is green?”)
Age 3.7 “Cup”
Age 3.8 “Cup”

Recently I had clear evidence that children construct their own visual schema and see through the eyes of their culture. Brittany, Joe's cousin was visiting from the States. We were reading a book together, when we came across a page on which there was a duck with some bulrushes behind. Brittany pointed to a bulrush and said "Hot dog". Clearly not a reference that a child from another culture would be likely to use.

**Bi) Imaging - seeing in the mind's eye**

After perception and memory, imaging is, I believe, the most important mental facility that we possess, a facility that Joe has already exhibited with reference to his visual schema. Imaging is the ability to 'see in our mind's eye' things which we cannot physically reach out and touch. One five year old put this very succinctly during a drama lesson, when she was asked to put her hand into an empty carrier bag and draw something out,

“I can see invisible things, I've seen them before”.

Imaging is a very powerful virtual reality simulating mechanism that we all possess to a greater or lesser degree. Einstein believed that visual imagery was far more important than thinking in words. McKim quotes him as saying,

“The words of the language as they are written and spoken, do not seem to play any role in my mechanism of thought... in thought are more or less clear signs and more or less clear images...”

Visualising is a skill rarely taught even though visual memory far outranks verbal memory. It is a skill that many adults are not sure whether they possess, possibly because it is not a skill that we generally value and any images that we do see, are by their very nature ephemeral. In fact, imaging is a skill that we use regularly in our daily lives, often unknowingly. How many times, I wonder have we been involved in the following situations?

- Talking to someone on the phone whom we've never met. What do we do but create a face to go with the voice?
- Driving along and seeing the road sign ‘HEAVY PLANT CROSSING’. Who has not mentally seen something that resembles a Triffid?
- Losing something and then trying to locate it, mentally retracing our footsteps, or as de Bono describes it, ‘A sort of playing through on the screen of the mind, of past or future experience’

Imaging is concerned with our ability to visualise. Nicholas Humphrey refers to the need for this ability as an 'echoing back to source' or an 'error detection mechanism', so that what is newly perceived may be checked back to source, making classification possible. Imaging also relates to seeing in the mind's eye what was. I believe that children have this ability from a very early age. Emily, Joe's sister, was 8 months old and on a home video she played with her baby gym. Her father peeped over the top and said “Atishoo!” and then ducked down.
behind. Emily then followed his movements. She could not see her father behind the baby gym so she glanced back to where she last saw him. It seems clear that she has a visual memory of where her father had been. This seems to be at odds with Gardner’s statement,

‘At the end of the sensory motor stage of early childhood, youngsters become capable of mental imagery’.

I believe that children become capable of mental imagery much earlier than this. Brittany at 15 months held a toy and pretended to lick it saying, “Umm, candy”. In order to make an object stand for something else she needed to be able to have a visual memory of what that object was before she related it to something else.

B ii) Seeing in the mind’s eye what wasVi
Visual memory has been vital to our survival. When Early foragers found the best places to locate food, then they needed to be able to retrace their footsteps. Even young children are able to memorise journeys. Jonathan 2.6, a colleague’s son, had been taken in the car only once to the local swimming pool. On the second journey his father asked him at each turn, “Which way now?” Every time Jonathan was able to point in the right direction. This feat of spatial intelligence is borne out in recent studies cited by Gardner,

‘It turns out that children age three or less can retrace a route that they know motorically’.

When Joe was 2 years 11 months I read him ‘The Blue Balloon’. On one page there was a blue balloon which folded out to become a much larger balloon. This larger balloon was multi-coloured. When Joe folded the page back so that only the blue balloon was visible, he said, “Colours still inside”, indicating that he had a visual memory for the multi-coloured balloon.

A month later Joe was visiting. On his previous visit he had been intrigued by a bee on the bathroom window. As we entered the bathroom again, he pointed to the window and said, “Bee’s not there”.

Three weeks from this occasion Joe began to use a constantly recurring phrase, “Do you remember.......? He would then add something that we had engaged in together. At this stage Joe has seemingly become aware of his ability to memorise and retain mental images.

B iii) Seeing in our mind’s eye what might be
In order to speculate we need to be able to use our existing knowledge to visualise how things might be.

When Joe was 3 years and 8 months he was watching a cartoon about dinosaurs. At the time of his watching he had also planned to do something with his mother, so he said,

“We’ll do it after the dinosaurs have gone and the writing’s gone up. Where does the writing go?”

His mother replied that she did not really know, so Joe said,

“I think it goes up there (pointing to the top of the screen) and into a pen and onto some paper”.

Joe here was mentally visualising a process rather than an object. He seems to be trying to use his existing knowledge, to make a connection between a computer monitor and its printout and a television screen with the printed word in evidence on the screen. He is quite used to seeing his parents use a computer and printing text from the screen. He is also aware that pens are necessary tools from writing, so this seems a very logical speculation for Joe to make. This seems at odds with Gardner’s statement (1983:179) that mental imagery, ‘remains static during early childhood... and children cannot perform mental operations upon it’.

At the age of four Joe was playing with a Duplo figure, moving it about in the air.

“The man is flying in the big balloon, but he does not have enough fire to get down”.

He was asked, “So what does he do? Can he get down?”

Joe said, “No, because he isn’t heavy enough to come down”.

Joe was then asked if the man would have to wait until he drifted down.

“No,” replied Joe, “he will eat his dinner, then he will grow bigger and he can come down”.

Again, Joe has visualised processes, that of the man eating and growing bigger and heavier, and the
resulting heaviness causing the balloon to come down. His knowledge and experience of life processes and forces has enabled him to apply this understanding logically in the context of his play.

In the classroom we need to use children's ability to think visually, by raising their awareness of this skill, so that they can use it purposefully. Its relevance is not solely related to designing as it is related to thinking, therefore is applicable across the curriculum. For example, recently I observed children being asked to write about the homes that they lived in. How else could they do this if they could not make a mental model of their house or take themselves around it? Another example would be children being asked to predict what might happen in a science investigation. To aid prediction they need to be able to visualise the likely outcome.

C) Modelling: making one thing stand for another

Modelling is the ability we have to make one thing stand for another. It enables us to understand the world we live in, so that we can control, manipulate and create it to suit our needs. Modelling is directly related to our ability to see in our mind's eye. Once we have visualised something we need to be able to externalise our ideas and thinking, so that we can further manipulate them. Modelling, whether in 2D or 3D further reinforces and activates our imaging, making the process a continuous one.

A model which represents something else may take a variety of forms, some more permanent than others. For example, it could be a drawing, hand gesture, a map, a collage, or a 3D model made from any material that might be to hand. Most models may be classified into three separate groups:

1) ICONIC- a model which realistically looks like that which it represents, such as a 3D model or a drawing
2) SYMBOLIC- a model which is an abstract of that which it represents, such as a map, but in which the thing represented is still recognisable
3) ANALOGUE- a model which looks nothing like that which it represents, such as a knitting pattern which does not realistically represent the final garment

There is also another form of modelling which may combine any of the above models and this may be called a SIMULATION model. This type of model may be found in computer simulation or role play.

Young children readily model the world around them, its systems, conventions, environments and products in order to understand and assimilate the culture that they are members of. They also construct and use all the different types of models for themselves.

When Joe was 3 years 3 months I watched him create an iconic model. The material was one directly to hand- icecream. We had previously gone over a bridge and talked about what it was made from and how it was fastened together. With his icecream in his tub in front of him, he began to make a model of the bridge. This immediately put me in mind of my childhood and using mashed potatoes as a modelling material!

Another example of Joe using food as a modelling material came when he was 3 years 8 months. I had read a story to him about some cheese. Immediately after we both went into the kitchen and I cut him a slice of cheese. Seeing the resulting rectangle Joe pronounced it a door and placed it on the table in front of him. "Cut nuvver door" he said. This I did.

When this second 'door' had been cut Joe instructed me to cut it down the middle. When I had cut the rectangle in half Joe said, "Those windows", which leads me to believe that Joe was able to mentally manipulate, and thus foresee the outcome. He then placed the cheese shapes in this format. He then instructed me to cut more windows. This...
time to my surprise he placed them in the above configuration. This was not the schema that I had anticipated, as it did not relate to the more regular schema that I held. Perhaps this is because Joe lives in a large, old, rambling block of flats, where the doors and windows in no way approach the standard schema for house. Nonetheless, he is still able to recognise the standard schema because he did so earlier when presented with the visual schema cards.

Another example of Joe modelling with food came via a home video taken when he was 3 years 11 months. Joe was eating toast at the time and holding a half eaten piece aloft he declared it a boat and ‘sailed’ it along in mid air. These last three models are all examples of symbolic models.

Another example of symbolic modelling in the form of map making, was one that I introduced Joe to, following his interest in maps. This interest was sparked by a trip to Liverpool when Joe’s parents had to use a map. Joe is avidly interested in books and appreciates that any signs or symbols ‘say’ something. On another trip to the Lakes Joe sat transfixed with the map on his knee. From this point I suggested that we made a map together. I drew his house, our house, and the roundabout and set of traffic lights that we negotiate. On our next meeting Joe said, “Let’s make a map” as soon as he saw me. At the time he was playing with stickle bricks so it seemed quite natural for him to use the material to hand, so the map was made of stickle bricks. This time the map represented his recent holiday in Cornwall.

At our next meeting Joe drew his very own map. The roads quickly became a train track as Joe had a particular mind set for Thomas the Tank engine at this stage.

"This is the way to my house".
"It turns into a train track to go to my house. Gordon puffs along the track".

"That's where your mummy lives".

"We need a round thing for the roundabout".
There is a film cannister on the floor next to Joe. He picks it up and draws around it.
"We need to put some soil in. That's all the flowers peeping out".

"That's the way to your house".

"That's down to Jessica's. Thomas the tank engine takes me down to Jessica's".
All of Joe's drawings I have annotated with his permission. This has encouraged Joe to see the purpose of writing and he has annotated some of the drawings himself. It is clear looking at Joe's drawings that analogues are the first models produced in this particular symbol system. For example, Joe has lines that represent a car, petrol, and a tyre.

"There's the engine. What else does it need? Petrol."

That's the tyre.

"That's the power to make it go there".

Figure 5

In the drawing below he depicts himself feeling unwell.

"That's me, not feeling very well".

"This is me, laying on my tummy".

"You can...

Figure 6

(From this point I decided to look for analogues in other symbol systems, particularly with regard to using construction kits. With Joe this was too late as he was used to using kits, but Brittany at 2 years 10 months had never used a kit before. Together we played with Mobilo. I showed her how to fasten the pieces together, then left her to play. Later the same week she played with the Mobilo on her own and presented me with a rectangle with hinged fasteners all around it and declared it a car. She then took a square, added fasteners to the outside and informed me that it was a man. This has simply opened up another avenue of research.)

Joe's drawings also showed examples of iconic models. The drawing below is a 'careful looking' drawing that Joe made of a model windmill. He took great care with this, commenting that we missed the round bit at the top. What is interesting about this is that he appears to be able to think three dimensionally. The windows of the windmill did appear like this as the body of the windmill curved round. The windows on houses he does not attach to the walls in this way.

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That's the tyre.

"That's the power to make it go there".

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Figure 6

Modelling is not solely concerned with the creation of things static. It is also concerned with creating systems, which may or may not include the manufacture of objects. The following model is a simulation model observed when Joe was 3 years 3 months. He devised a game based on Postman Pat. He, of course, was Pat, travelling along the highways and byways of the living room on his bike, which represented Postman Pat's van. Postman Pat often shopped for the residents of Greendale, so Joe would make the kitchen represent Mrs. Goggin's house, and he would ask her what she wanted. He would then go to the next house which might be his
bedroom. This would be where Reverend Timms lived. Joe would then go back into the living room and do the shopping, then take it back to Mrs. Goggins et al.

Joe here, was structuring his own events, modelling his ideas through role play in order to assimilate his experience. Another interesting aspect here is that Joe uses nothing (the shopping) to represent something, a common practice in young children.

Whatever kind of model Joe uses, he always has to breathe life into it, either by enactment, talking it through, or both.

This is also true of the models that adults use and make. As Ken Baynes says (1992:13),

'We can only use models that have life and meaning breathed into them by perception, imaging and understanding'.

It is evident that children enter formal schooling with a wealth of knowledge and experience relating to design, particularly imaging and modelling, which should be utilised and built upon. The process of designing is fundamentally a learning process, with applications across all subject areas. Children and many adults use the process and process skills unknowingly. We should try to raise children’s awareness of these process skills and the interaction between imaging and modelling, in order to enable them to see and understand, what and how, they are thinking.

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