How might we develop young children's problem skills?

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Aims of the project

To examine children's responses to a number of practical problem-solving tasks, how they explain their decisions, and how they use diagrams (with symbols) to record the process.

Dimensions of the study

This research project was carried out in a primary school in a socially deprived area of Leicestershire. The study involved children in the Foundation Stage, Year 1 and Year 2. The children were presented with a problem-solving task. They were encouraged to record their approaches on paper by using symbols to record how they solved the problem in picture/drawing form. We examined their responses to identify progression in their use of the symbols and positioning of them on paper, and to identify possible reasons why differences occur in how each child approached the task and recorded their findings. We felt this would enable us to provide our children with the support they needed to move on to the next stage. We selected children of varying abilities and ages to see how children represented their ideas or used symbols differently on paper at different stages of development.

Summary of main findings

We found the children's drawings showed five stages of development:

- Some pictures recorded – but no connection with objects to show how problem was solved
- Pictures that indicate symbols used to represent objects. Some connection with how problem was solved
- Clear symbols shown and a 'map' format drawn with positions and some labels
- Clear symbols that are all labelled. A map drawn to show route
- Clearly labelled symbols, marking out map and finding alternative ways to solve problem

The children who talked aloud as they went about solving the problem using the construction equipment seemed to do better drawings and position the drawings on the page better than those who didn't talk. Their verbalised thoughts were reflected in their drawings. Asking the children to describe what they had done and give reasons for how they had gone about solving the problem appeared to help them to develop their ability to record their solution more accurately.

Background and context

The children's home background is not one in which they are encouraged to solve problems although they do enjoy challenges. They come to school with very poor language skills. The eight children chosen for the task were of mixed ability and with a balance of boys and girls. Six of the children (three boys and three girls) were in the Foundation Stage, one (a boy) was in Year 1 and one (a girl) was in Year 2.

Teaching processes and strategies

The problem-solving tasks included:

How can the person cross the river without getting wet?
The problem required children to work out how to get a playmobil person from one end of the river (a long piece of blue paper) to the other so they could get to their house. The challenge was for them to design something that could get the person to the other end without the person getting into the water. The children had a wide variety of construction to choose from, Lego, mobilo, duplo, cogs and wheels and other similar equipment.

How can Big Ted rescue Little Ted from snakes in the desert?
Big Ted and Little Ted were positioned at diagonally opposite ends of the sand tray. The sand 'was full of poisonous snakes'. The children had access to the all the usual classroom construction equipment.

What kind of structure would help the rabbit reach his food?
The children were asked to build a structure out of Lego that would enable a toy rabbit to reach his food on the other side of the carpet. They were told that the rabbit could not touch the carpet as this was a poisonous swamp. They decided they should build a bridge.

Carrying out the tasks
Each child was asked to complete the task individually. Before they started we described the problem to them. For example: 'This person has got a problem, he needs to get to his house but it's at the end of the river. He needs something to help him get across the river to his house, but he is not allowed to go in the river and

get wet'. The children first completed the task physically, building an appropriate structure using the construction equipment and using it to transfer the toy. Afterwards, they were asked to draw their solution in case the problem happened again so that their friends would know what to do.

We wanted to see how the children approached the task without giving them any guidance though we encouraged them in their efforts. We then repeated the same problem-solving task but this time we encouraged them to explain their reasoning to see the effect talking about their solution had on their recording of it. For example we asked them 'Why does your boat need sides?'

The findings

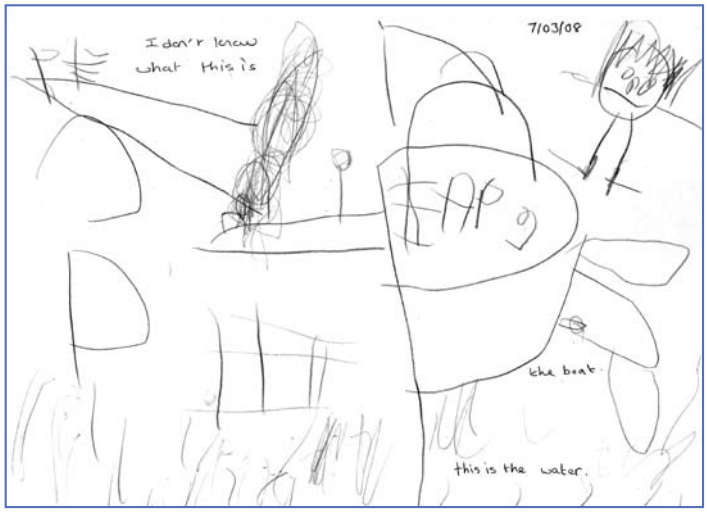
Here we present examples of the solutions given by a child at each of the stages we identified, the approach the child used and the way the child recorded it.

Stage 1

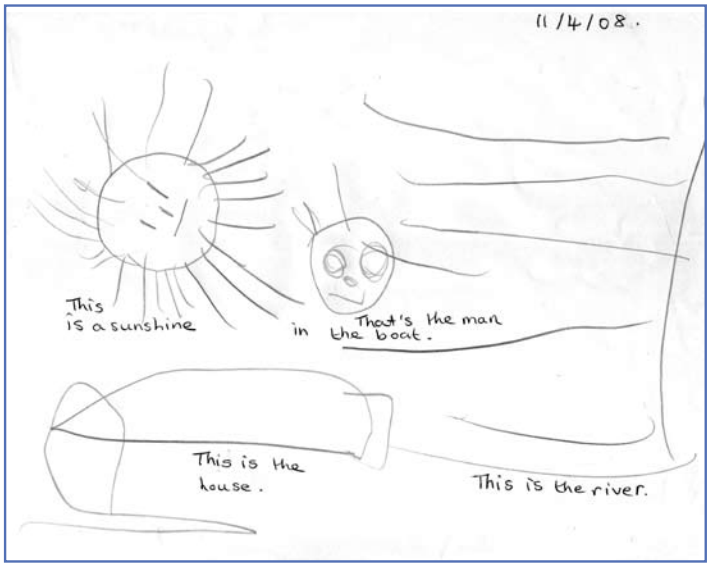
Child B approached this task in a trial and error way. She started by putting duplo bricks together and said, "I can't make a boat". She then proceeded to experiment in putting duplo bricks together like a tower. She did not talk at all as she was doing this.

Drawing the task using symbols

Child B started off by drawing sunshine on the paper. She drew random shapes that she said was the boat and other marks she said she didn't know what they were. She also drew a figure of a person. Her approach to recording was very similar to the way she approached the task physically. She did not use language to talk through the process in either case. The symbols she used were unconnected.



Child B started her second attempt at recording in a similar way to the first. She first drew a sunshine. It may be that she saw the man in the boat on a sunny day. This time though she made more connections with the symbols she was using and what they meant. She said, for example, "This is the house", "This is the river", "This is the man in the boat". She had made progress in the sense that even though the symbols were not in the right position she knew these symbols needed to be used to represent what she had done and the symbols were positioned in a more logical manner.



Stage 2

Child C immediately said, "I can make a boat with these". She chose the cogs and wheels square pieces and she started to put them together in a line: "I've got to put the edges on now". She proceeded to put a piece at each end. She used language constantly to describe her thought processes: "I'm going to do the roof. I think I'm going to take forever. I've got a really long boat". She proceeded to make the roof and build the sides up: "I need to work this out. This bit goes there, yeah, I've worked it out now". She had made her boat with the sides. "I've done it".

Using symbols to represent the task

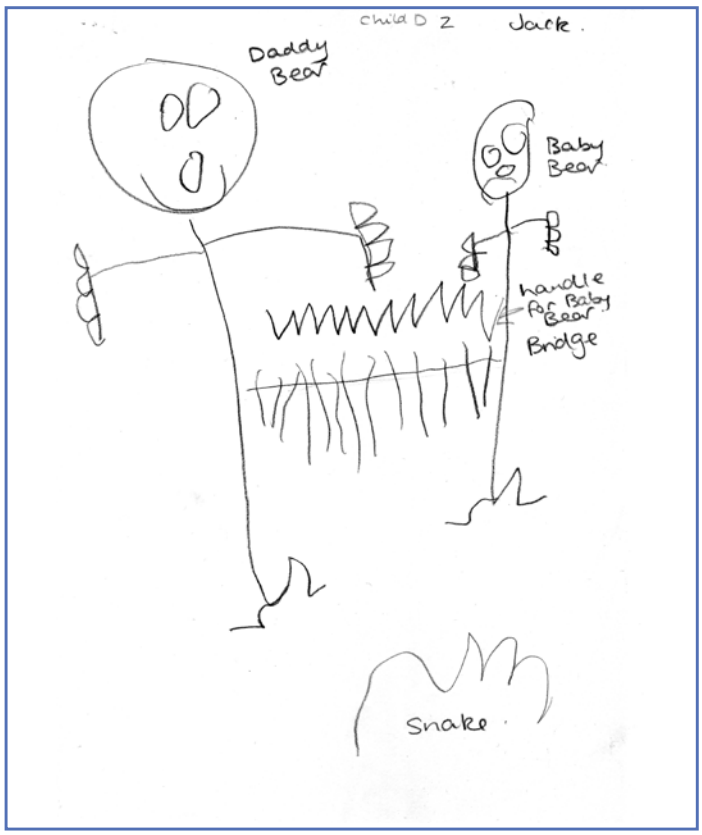
Child C knew what symbols needed to be used to represent the things in the task. She drew the boat as a square and used lines to represent the cogs and wheels. She did blue for the river at the bottom and a man and house on another piece. These were not necessarily in the right position but she could describe parts of the symbols e.g. "That's the edge, that's the top".

On the second attempt she used plastic bricks, but she used the same thought processes to describe what she was doing. She used language such as "I need to make sure he doesn't fall out". Progression with how she positioned the symbols was evident the second time. She showed the house and the person at opposite ends and the river underneath. She talked through her drawing in the same way that she had talked through her construction: "I'm going to start off with the house". "This is the river".

Stage 3
Child D instantly said that he was going to make a bridge to enable Big Ted to rescue Little Ted, selecting the large cogs and wheels to make it. He said "Teddy is going down the ramp, creeping past the snakes and up the ramp to Baby Bear".

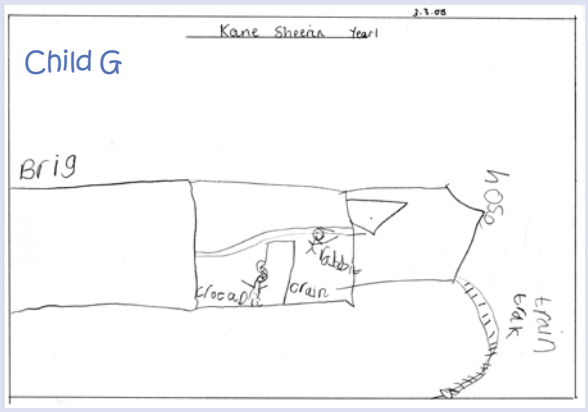
Using symbols to represent the task
Child D drew the bears and the bridge on top of each other. He drew Big Ted with a happy face and Little Ted with a sad face because "Daddy Bear had built a bridge to save Baby Bear and Baby Bear was sad because he wanted his Dad". When we looked at his drawing and at the bears in the sand tray he could instantly see what was wrong with his picture.

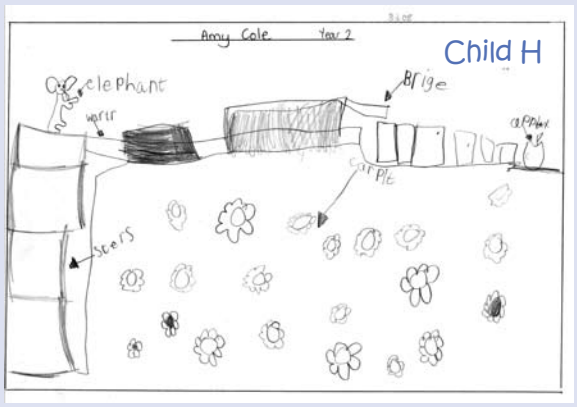
When Child D repeated the task he again selected large cogs and wheels and made an identical bridge. His drawing again had the happy and sad faces, but this time the bridge was adjacent to the bears hence connecting them. He added a handle "to help Baby Bear".

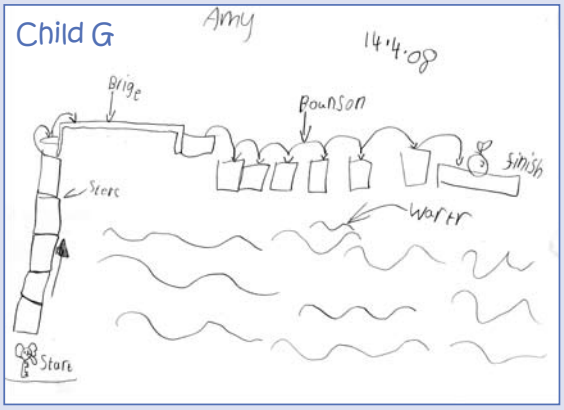


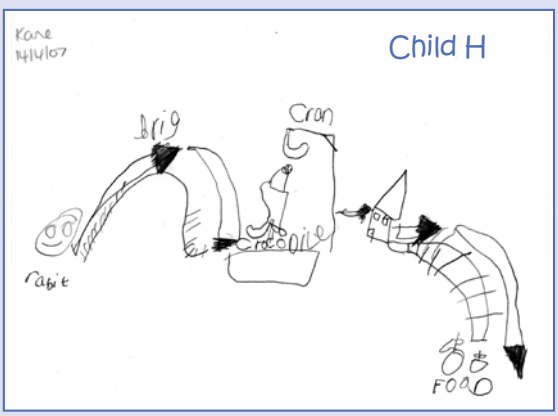
Stages 4 and 5
The pictures here were drawn by the Year 1 boy and Year 2 girl after they had completed the practical task of building a structure out of Lego to enable the toy rabbit reach his food without touching the poisonous snakes.

Over the following four weeks their teacher worked on using symbols to represent how they solved problems. The children then repeated the task and were asked to record again, on paper.









Research methods

We recorded how the children approached each task in terms of the language they used, the strategy they used and the symbols they used to record their solutions, including the relationships between the symbols.

We collected the following data:

- photographs showing how the children did the practical task
- children's representations of their ideas on paper using symbols to represent what they had been doing
- a record of any language the children used to describe what they were doing/drawing

Conclusion

From the strategies used by the children, their discussions of the approaches taken, and the diagrams recorded by them we concluded that:

- the children approached the tasks in a variety of different ways
- some children naturally used language to describe their thought processes
- some children found it easier to use symbols than others did. Children may not have developed the spatial awareness or may not be able to internalise what they see enough to represent their solutions using appropriately positioned symbols
- articulating their thought processes appeared to help the children with recording what they had done in symbols
- talking with the children about their constructions and their recordings enabled all the children to develop their ability to record their solutions using symbols

This research has brought home to us just how difficult it may be for children to put their ideas onto paper (some found drawing quite daunting) and how children's efforts need to be valued for the process and their attempts and not on how the end product looks to the adult. We found it interesting how different the children were – how they do things very differently, approach tasks in very different ways, record in very different ways, position symbols – even though they are the same age.

Carrying out our research has also made us 'stop teaching for a bit'. Whereas before we might have modelled every approach the children could use, practically telling them what to do, now we try to take more time to work out an individual child's difficulty and see if s/he can go a step further. We do this by asking them questions that scaffold how they can work out their own solution or encouraging them to try talking about it to a friend. We then give them credit for coming up with their own ideas. We avoid showing them how to do it. We've always tried to encourage the children to be independent, but now we are more conscious that we are doing it.

References

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All conference materials are available at www.standards.dfes.gov.uk/ntrp

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National Teacher Research Panel
engaging teacher expertise