Interaction, dialogue and a creative spirit of inquiry

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Abstract

The aim of technology and design is 'to enable all pupils to become confident and responsible in solving real life problems, striving for creative solutions, independent learning, product excellence and social consciousness' (NICC 1991: 15). A main aim of the present study was to create an environment and climate for learning that would enhance design capability and problem solving. To achieve this, pupils from two Year 7 classes (mean age 11 years-old) were organised into groups of four as creative learning communities. Working collaboratively and co-operatively pupils were able to discuss, clarify, brainstorm, think through their ideas, negotiate and arrive at a shared contextual understanding for their talking, thinking, planning and making. A local story was used as a stimulus for critical and creative thinking and as the platform for design and technology activity.

Methodology included digital video and audio recordings, picture capture, classroom observation, pupil and teacher semi-structured interviews, teacher logs, researcher field notes, project evaluation.

Findings, from the transcripts of classroom-based discussions, showed that active participation and careful scaffolding of the learning by the teachers, enabled pupils to achieve at a higher level than they would have done if left unassisted. Individual creativity and problem solving was enhanced, as evidenced by the high levels of pupil engagement in the process and diversity of pupil outcomes. Dialogue, interaction and a creative spirit of inquiry were significant in the teaching-learning process. As technologists, pupils were learning how to learn and thinking how to think within a context that was real and of interest to them.

Keywords

interaction, thinking, dialogue, engagement, enquiry, creativity

Rationale

Research has shown that classroom reality has tended to concentrate on a transmission model of teaching where content is received and where there is little need for modification or adaptation of it by the pupil (Wallace, 1996). The teaching and learning approach underpinning the present study is based on constructivist and sociocultural perspectives of learning (Watkins, 2001). These aim for increased learner awareness of the nature and process of learning and place an important emphasis on dialogic activity (Mercer, 2000; Newton, 2000). Through dialogue and practical activity, new understandings and meanings are created and communicated in the process of arriving at a satisfactory solution to design problems. Higher order thinking skills such as observing, inferring, comparing, proposing, hypothesising, applying and evaluating integrated design and technology activity with the knowledge required to solve practical problems and produce creative solutions. Creativity in thinking and practice is developed through intellectual engagement, purpose, energy and interactive tensions with others (Syrett and Lammiman, 2002).

The pupils in this study became involved with a project that was based on a story entitled: 'The Day The Monster Called' by John Gray. The story fired their imaginations and engaged their curiosity and interests. The context for the story was their local environment, which centred on the Belfast dockland. A monster with a huge nodding head and swishing tail had emerged from the sea and was threatening their neighbourhood. Ways of enticing the monster back into the sea had to be discussed and agreed. The activity engaged the pupils in technological and philosophical enquiry and learning across the curriculum. Through dialogue and enquiry the pupils identified, analysed and solved various technological problems. Through dialogue and enquiry they grappled with philosophical issues that, in contrast with the technological, did not have immediate and clear-cut answers. In considering alternative and equally plausible ways of solving a problem, pupils experienced cognitive conflict. This can lead to conceptual change and development (Posner *et al*, 1982).

When considering whether it was right to kill the monster, a range of questions emerged: animal welfare, security, whether animals have a conscience,

should animals be killed, is there such a thing as the right thing to do, people behaving like monsters. The philosophy of thinking and doing that underscores practical activity and the philosophy of everyday inquiry merged through the story. The teachers maximised the potential of the many questions children raised as they reflected on the issues contained within the story (Gardner, 1996; Lipman, 1997). In addition to the design of monsters and cranes, the pupils discussed and expressed their ideas and feelings through drama, song, poetry and story. Pupils need to be active in their own learning and develop cognitive strategies and beliefs that enable them to take greater control and responsibility for it (Costa, 2002).

Methodology

The teachers involved were interviewed before, during and after the activity to determine their views on the value of pupils operating and working collaboratively. Questionnaires, semi-structured interviews and the researcher's field notes were used in the data collection process. The teachers shared the learning outcomes of each lesson with the pupils by writing them on the whiteboard at the beginning of each lesson; they kept a log of the project and noted all the new technology words to which pupils were introduced.

Words like cantilever, equilibrium, balance and counterbalance, weight and counterweight, forces and energy were used with meaning and purpose. Photographs were taken of the work in progress as well as of the final learning outcomes. A wall display of pupils' work included individualised terrace house designs, poems based on 'Our Wee Street', maps that used six point grid references to locate familiar landmarks, balance equations and calculations used in the design of the cranes, details of experiments carried out with thin and thick card structures, as well as the monster and crane designs.

Audio recordings of pupil and teacher interactions during the constructional activity were transcribed as 'learning conversations'. These then became the important focus of this research investigation. Significantly, the language and technological vocabulary that was used showed a high level of technological awareness and understanding.

The use of a story and the opportunities that it provided to think through the issues had real meaning and purpose for the pupils. When discussing an idea of either technological or philosophical origin, pupils were encouraged to give reasons for their thinking: explain, clarify, compare and contrast, elaborate, construct, imagine, predict and hypothesise. Rules of engagement were discussed and agreed with the class as a whole: share ideas; give reasons; question ideas; consider alternatives; agree or agree to differ; involve everybody; act responsibly (Mercer, 2000).

Main findings

The aim of the overall project was to provide an integrated set of learning experiences through which pupils were encouraged to talk, think and act collaboratively. It is beyond the scope of this research investigation to report on all of the findings originating from the classroom-based research activity. Only those pertaining to classroom interaction, i.e. pupil dialogue and the use of language and enquiry in children's conversations, will be discussed. The main focus of this study is on the naturally occurring classroom discussions which arose in both whole class and group settings. Analysis of the video recordings and transcripts of speech provided the researcher with evidence of children's thinking and problem solving capability in the form of learning conversations or learner-centred narrative (see appendices).

In considering ways of returning the monster to the sea, the pupils were encouraged to explore different possibilities and alternatives and give reasons for their ideas. In this teacher-led whole class discussion the importance of valuing and respecting different points of view was emphasised and certain 'rules of engagement' were highlighted. Relevant photographs with a neighbourhood and community emphasis provided a good resource for dialogue and enquiry. A photograph from a local newspaper showed Margaret, at 102 years of age, having to move for the last time from her East Belfast terrace house. A second photograph showed 10-11 year-olds in 1911 going to the seaside. In groups, the pupils were able to tease out the similarities and differences between life in the 1900s and the 21st century and arrive at some shared understandings. Familiar landmarks in the story were located on maps using six-point grid references. Engagement in this kind of collective thinking and social activity provided the backcloth for design and technology problem solving.

In developing ideas for returning the monster, an internet search showed that this type of monster was partial to fruit and vegetables. The agreed solution was to transport apples from Co Armagh and use the cranes from the docklands to offload the apples and build a trail back to the sea. Working in groups and individually, pupils set about designing and making monsters with nodding heads and cantilever cranes that could suspend the weight of at least one apple. Through experimentation, trial and error, calculation

and purposeful pupil talk, pupils began to design and model cantilever lifting systems and monsters that had nodding heads. The pupils were acquiring a grasp of technological and related concepts through learning how to operate with them and by using them in creative and imaginative ways. The transcribed 'learning conversations' revealed a significant use of teacher praise, encouragement, prompting, probing, questioning and support throughout the designing and making process (Appendix 1). Pupils' talk tended to be of the exploratory kind and was especially meaningful to those doing the talking (Appendix 2).

Vygotsky, 1987, made the important link between 'internalisation' of social activity and individual development. Research has shown that individual reasoning is an inner dialogue that can be improved through engagement in intelligent conversations (Wegerif, Mercer and Dawes, 1999). Design and technology is uniquely placed to provide pupils with a social context for talk and action that has both meaning and purpose – a community of enquiry (Lipman, 1991). Through interaction, dialogue and enquiry, the children were internalising the rules of engagement and improving their reasoning and problem solving capabilities. This research has highlighted the importance of the teacher or a more knowledgeable peer in the scaffolding of individual thinking and learning through joint activity (Appendix 3).

Teachers and pupils were active participants in the teaching-and-learning dialogues. Pupils were encouraged to talk and think through their ideas together and teachers were effective in the support given: open questioning, prompting, probing, explaining and guiding. Through interaction, the pupils were making their own thought processes visible, they were encouraged to give reasons for their thinking and the teacher could respond appropriately and effectively to the teaching-learning requirement. Language was being used as a tool for collective thinking and reasoning in the problem solving activity. After the project was finished, the pupils used language constructively to engage in reflective comment on what they had learned (Appendix 4). Analysis of the video recordings and transcripts of speech enabled the researcher to generate three main findings about the teaching-learning process and the important role of the teacher in that process.

Participation in 'learning conversations' (conversations that enhance thinking and learning) has a particular value within design and technology where the emphasis is on the use and application of knowledge in problem solving activities. Pupils need to engage in the knowledge construction process and have opportunities to construct their own meaning so that knowledge can be useful to them: *main finding 1*.

For some activities the pupils were organised in groups of four as a community of enquiry. Through collaboration and real engagement with the issues and problems, the pupils were enabled to arrive at a collective view of how best to proceed, adapt and generally progress their thinking. The teacher acted as an important mediator and facilitator in this process as the pupils brainstormed ideas and constructed knowledge and meaning. The purposeful nature of the activity enhanced pupil motivation and this in turn increased the creative capital of the group: *main finding 2*.

Engaging in the process of knowledge construction within a community of enquiry provides significant opportunities for pupils to use language in particular ways. Analysis of the emergent 'learning conversations' from pupils engaged in a group approach to the monster design showed pupil talk to be of an exploratory kind. Flexibility within design and creative thinking was evident in the reasoning, hypothesis generating and imaginative talk functions that were identified. The effective teacher will plan to take cognisance of this diversity of talk functions within teaching and learning: *main finding 3*.

Main finding 1:
There is need for a shift in emphasis from transmitting meaning to constructing meaning.
Teachers need to view learners as active participants in the construction and co-construction of their own learning and meaning making. Through the use of dialogue and enquiry, meaning and understanding were being socially constructed (Edwards, 1993; Lemke, 1990; Mercer, 1995; Wells and Chang-Wells, 1992). Significantly, pupils need to acquire a grasp or understanding of that which gives sense to the knowledge: the experimentation, dialogue, modelling, testing, observing and finding out: a creative spirit of enquiry. Attitude and disposition are important and evaluation and reflection are identified as core abilities. Engaging in the process also helps learners become more explicit about their learning and makes learning an object of conversation and reflection (Watkins, 2001).

In this study, pupils liked the practical activity, they enjoyed the creative process, they accepted the responsibility it gave them and they increased in confidence and self-esteem. More importantly, they thought it was fun: learning is fun and we can do it was the unwritten pupil assertion. When questioned about learning outcomes, Sarah's reply was most interesting:

> 'We learnt about specification, equations, equilibrium, and we did experiments ….. it was really good fun.'

This was a reflective response spoken spontaneously by Sarah four weeks after the project had finished. When the pupils were asked to put their newly acquired technology words into a sentence, Charlotte recorded:

> 'The loads acting on the beam are in a state of equilibrium.'

It is interesting that the word 'state' had not been used during the project. The meaning of the sentence had been determined contextually through real and purposeful engagement with the project activity. Pupils were enabled to make various cross-curricular links and a holistic approach was evident in their personal and collective evaluations.

Chris in explaining his design for a monster trap (Figure 1) said:

> '…there are iron walls, a bit like prison windows…OK…and they are underground…camouflaged by grass and in the very centre there are weight sensitive panels which have meat and vegetables on it. Once the animal comes in and touches either the veg. or the meat the sensor sends a signal to the computer which activates these hydraulic lifts, which push the iron bars … the iron walls… up, and the computer sends a message to this other computer which has a person in front of it and then that person comes with a radar tag and puts the tag on the animal before letting it free.'

Chris's design solution was located underground and camouflaged. It made use of weight sensitive panels and sensors, it utilised computer control and computer networking and it incorporated hydraulics and radar frequencies. This design solution represents a high level of technology awareness and understanding for an 11 year-old pupil.

Main finding 2:
Creative minds are developed by building communities of learners.
Capability is dependent on the development of qualities such as open-mindedness, flexibility, tolerance of uncertainty, adaptability, resilience, resourcefulness and reflectiveness (Claxton, 1999). Such abilities and dispositions are fostered within a creative learning community, in which thinking is seen as a kind of reasoned argument with an explicitly social dimension (Kuhn, 1991).

Discovery like surprise favours a well prepared mind (Bruner, 1996). It is only when information and ideas are connected in the mind that they can be more readily accessed and worked on, at times subconsciously. Creativity and the capability to act in creative ways are expanded through building networks of connections within the mind and with other minds within a learning community (Fisher, 2002). Dialogue plays a vital role in the connecting and interconnecting of minds by offering ideas, suggestions and possibilities that causes one to think, think flexibly and think for oneself. We build communities of creative learners by encouraging inter-connectivity of minds that in turn enhances individual capability and the ability to act. In reality, the better the connections, the better the learning and the greater the potential for surprise and ideas that are different or unique.

The quality of the teaching-learning partnership within the present study enabled the pupils to operate within multiple zones of proximal development

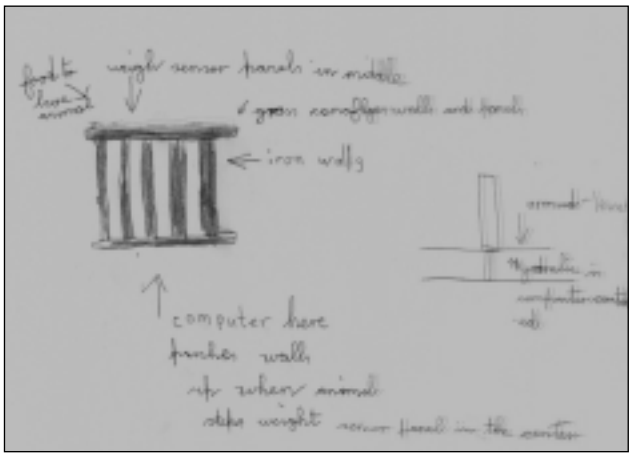

Figure 1: Chris's design for a friendly monster. trap

Figure 2: Monster and crane models designed and made by the pupils.

(Vygotsky, 1962). The video recordings showed pupils engaging in verbal exchanges, listening to partners at critical times, demonstrating a practical operation (tutoring), learning from one another and interconnecting with each other. In such a creative mix of collaborative endeavour and collaborative conversation, the connected mind was stimulated into imaginative thinking and action.

The monster in Figure 2 is shown approaching an apple suspended on the jib of a crane. The design and written work in Figure 3 shows a commitment to work that is attainable only when pupils are empowered in their learning, are in control of it and want to be involved.

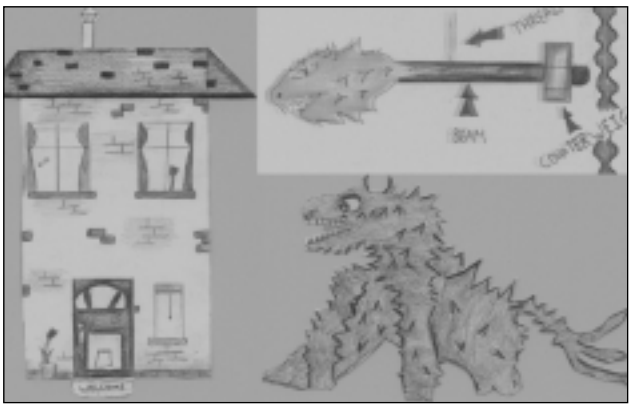

Figure 3: Individual design work: terrace house, monster design and mechanism design.

Main finding 3:
There is need for an increased emphasis on the social and contextual features of the learning process.
Through dialogue, enquiry, modelling, evaluating and modifying ideas, pupils felt empowered to take their thinking and learning forward. They took ownership of the activity and this was evident in their high levels of engagement. Personal engagement is a prerequisite for the construction of the meaning and conceptual change (Wittrock, 1994). By reflecting on personal and shared ideas, the pupils were developing their metacognitive knowledge and experience (Bereiter and Scardamalia, 1987; Brown, Armbruster and Baker, 1986). There was an evaluation of both the process and content of creative enquiry when engaged in creative problem solving. An overriding emphasis was on the development of good thinking; children being able to think, plan, make decisions and demonstrate creative capability.

Analysis of classroom interaction enabled a framework of 16 different talk functions to be

Year 7 experiencing the balancing principle.

Simon perseveres with the head mechanism.

Sarah and Laura acting out a street scene!!

Enacting the story with a Year 5 group.

assembled (Kumpulainen and Wray, 2002). These functions characterised an exploratory mode of talking, thinking and learning. Learning was viewed as an interactional process that used language and other semiotic tools as both personal and social resources (Halliday and Hasan, 1989; Wells and Chang-Wells, 1992).

Analysis of the dialogue showed that the Hypothetical, Experiential, Reasoning and Imaginative talk functions were used frequently during collaborative design and technology activity (Appendix 5). The importance of these functions in developing children's thinking and learning is well documented (Edwards and Mercer, 1987; Mercer, 1994, 2000; Phillips, 1990; Wells, 1987). Exploratory discourse was characteristic of the design and technology interactions and exploratory activity was evident in the diversity of practical outcomes pupils produced.

Conclusion

Evidence of language functions – initiating, externalising, heuristic, imaginative – within peer group interaction, reflects the kind of exploratory talk in peer-group interaction that is significant in learning (Barnes and Todd, 1977). Teaching methods and teacher conceptions of teaching and learning influence significantly the quantity and quality of children's exploratory talk in the classroom (Mercer, 2000; Costa, 2002). A new mindset is needed in order to move away from a transmission view of teaching-learning to one based on transaction and active processes of learning.

The present study commends a more integrated and holistic approach that connects all aspects of learning: the skills, content, purpose, contexts and tasks (Carnell and Lodge, 2002). A sociocultural view of learning views education as social interaction with knowledge and meaning generated and constructed through engagement with the activity and peer-group interaction. Pupils are operating within multiple proximal development zones and teachers are key agents in scaffolding the learning and understanding process (Vygotsky, 1978). The evidence confirms that requiring children to express and model their understandings in a variety of symbolic and practical ways is key to their intellectual and creative development.

The design and technology activity, with its potential to engage children in real and meaningful learning experiences, provides an excellent vehicle for integrating teaching, learning, thinking and understanding. It is through exploratory talk and exploratory activity that ideas begin to take root and develop and connections in the mind are made and secured. This case study is concerned with the cultivation of certain attitudes and dispositions that are considered favourable to thinking and learning. It is through engagement in exploratory talk and action that pupils are empowered to think for themselves, use their imaginations, make decisions, learn and develop individual capability.

The capability to think, plan, do, review and apply is fundamental to individual, diverse and creative empowerment. The creative learning environment advocated in this study is one that shifts responsibility from teachers to learners, provides a focus on active learning and an emphasis on reciprocal teaching and learning (Watkins, 2001). The capability curriculum needs a new thinking and learning orientation that has an emphasis on learning with understanding so that pupils can act on personal and collective knowledge and information with imagination and creative energy.

The findings confirm that the teacher is key to providing a context that promotes collaborative modes of learning by fostering interaction between learners. Ideas do not come pre-packed and ready-made, but have to be constructed, negotiated, developed by the pupils and then used. This happens when attention is paid to the classroom learning context as a whole. Pupils need to acquire collaborative learning skills, since skills of discourse and creative enquiry underpin effective interaction and learning. Structuring contexts for exploratory talk and activity stimulates the hypothetical, experiential, heuristic and imaginative language functions within whole class and group discourse. In doing so, creativity is made to flourish and individuality and diversity become main learning outcomes.

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Appendices

Appendix 1

The wire used in the mechanism for the nodding head was soft and easily manipulated. This presented an immediate problem to some children. The following is a part discussion with the teacher about how the situation could be resolved.

(T = teacher)

Barry	the wire is easily bent
T	and how do you overcome that one Barry?
Barry	keep the wire as short as possible
Simon	you could strengthen it in some way
Sarah	I put a bend in it …a bit like a triangle… bend it into shape…strength…it's better…(pause)
Amy	you could tape the ends of the wire to the sides of the structure the way Vanessa has done
T	very good…(**T** reaches out and holds up Vanessa's model and talks about how she overcame the problem)…Vanessa has come up with a really good way of suspending the beam using a short length of wire effectively.

(Vanessa's 'invention' and an understanding of how it works make it possible for the pupils to complete this aspect of the model satisfactorily.)

Observation

Vanessa made the invention and the teacher scaffolded the children's thinking through prompting, probing and questioning.

Appendix 2

Children's talking within design and technology tended to be of an 'exploratory kind' and was especially meaningful to those in the groups doing the talking. To a non-group member the discourse may have seemed somewhat incoherent. For example, the following is part of a 'learning conversation' which took place during a group discussion of Scott's monster trap, with Gareth questioning Scott about his idea for releasing other stray animals caught in the trap.

Scott	…like it would fall like…err, … err,…like it just slides down the chute and escapes like.
Gareth	escapes…you mean like…
Scott	there is straw…something soft like…
Gareth	tunnels like…into the forest ?

Observation

Only those who are 'doing the talking' understand the use and meaning of particular words. The group members seem to be able to infer sense from the few words that are used because they relate to a particular context known only to them. The context either enables them to complete the sentence in their own minds or acts as a trigger to its meaning and understanding. It is as if they are members of a particular club with their own 'rules' of operation. This kind of exploratory talk is embodied in other important social practices such as medical, law, science, business and the world of work.

Appendix 3

Learning conversation: similarities and differences

The following conversation arose from the teacher observing some children who were experiencing difficulty with the balancing principle. This needed to be understood so that it could be applied within the monster design to cause its head to nod. This group of children was having difficulty making the head of their monster nod.

The children who had succeeded had chosen to suspend their balanced beam from a wire rod using thread. The balanced beam had a monster head at one end and some blu-tack acting as a counterweight at the other end. The children who were having difficulty had inserted the wire rod through the pivot point of the beam causing the beam to swivel about that point. It is only when the beam is suspended and balanced that the desired nodding effect is obtained. The challenge for the teacher was to enable the children to see and understand the similarities and differences between the two situations, to learn from these and to take appropriate action.

T	let's look at Sarah's model…Sarah has used blu-tack for the counterweight…what else could she have used ?
Simon	sellotape … scrunched up sellotape
Gareth	plasticene …a metal nut
Judy	pieces of heavier card glued together
Amy	paper clips
T	very good…all of these are good ways of making a counterbalance…are there any more?

Barry bits of old rubber joined together at the end of the beam

T good Barry…if you have an idea try and use it…each monster can be different…we want Judy's to be different to Gareth's, we want some variations, some changes … all monsters and animals are different. What do you think Amy?…I know you have a dog…in what way do you think your dog is different to all other dogs?

Amy he can be naughty when he wants to be…so he is similar to other dogs…BUT…his tail is very different because he had an accident… so he is different

Sarah our house is similar, but it is also different to the other houses where we live … I never really thought about it that way before

T very good…those are good examples of similarities and differences…our monster designs are also similar but different. To make the monster nod some have inserted the metal rod through the pivotal point of the beam and in this case (holding up Sarah's model) the wire is above the beam and the beam is suspended from it by means of thread…does that make sense ?…Can you spot the differences and know why they are different ?

Appendix 4

Reflective comment on the monster project (Sarah, Amy, Gareth and Simon four weeks after the project)

Observation
This reflection highlights how the pupils were able to engage in an intelligent conversation on their own about a project which they had completed four weeks earlier. The links show how intense the learning conversation was and the different ways in which the pupils were able to pick up and elaborate on each other's comments. For them, the learning was real and the emotional attachment with the project significantly aided understanding, recall and proper use of the main technology words and concepts.

Reflective and continuous comment: links and ties

Sarah we found out quite a lot of general knowledge and information about what a dry dock was – a lot of us wouldn't have known what a dry dock was … we found out about the **cranes** and what the different parts of a crane are called

Amy lots of people wouldn't have thought about the **triangles** and their great **strength**

Sarah Yeah, lots of people wouldn't know that a **triangle** is the **strongest** shape and that you can make a very strong structure

Gareth yeah, jibs, and **counterweights, balance and counterbalance**, we found out through the story – people see **cranes** and don't think of the **weights** (counterweights) needed at the end to **balance** the other **end** or what they are **lifting**

Sarah before we did the project I did not know, did not have a clue, there was a **counterweight** at the other **end** of a **crane**. I just thought it's so **heavy** on the other side it just **lifts** up whatever it is and turns it (places it, in its new position) … I didn't even think about **balance** or that it would **tip up** if there was too much **weight** on **one side**

Gareth I thought it was just attached to the **ground** - big steel bolt things - and that kept it from **falling over** when it started **lifting** things

Simon I thought they were concreted into the **ground** to keep it **balanced** …. didn't think about the **weights** and **counterweights** – that's amazing as well

Amy I didn't actually realise that **cranes** had wheels or could travel along …. it makes you look a lot harder at things you let pass by

Appendix 5
The tables shows a range of talk functions that were highlighted within exploratory talk and used during collaborative design and technology activity.

Student	Transcribed peer interaction	Language functions	Cognitive processing	Social processing	Contextual notes
Simon	good idea…what size of wood do we need…I'll cut it…that's good…what about the beam…could we use the string…?	Affective Initiating Experimenting Imaginative Organisatinal Modelling Experiential Anticipating Reasoning	Planning Organising Responding Experimenting Checking Monitoring Problem solving	Simon is supportive but challenges Charlotte through the questions he raises. Volunteers help and offers praise. Values and welcomes ideas on offer	Analyses an idea initiated by Charlotte. Volunteers assistance and makes a helpful suggestion.
Sarah	we could tie it round the wood…it might work…let's try it …(modelling)…that's no good	Exploratory Modelling Heuristic Reasoning Judgemental Initiating Externalising Imaginative	Exploring possibilities Experimenting and speculating. Using imagination Learning from the situation. Planning and checking	Sarah offers to follow through the idea, test it and see what happens as a result.	The string is now wrapped around the flat section wood and the beam is suspended BUT the head still wobbles from side to side.
Charlotte	why is that…the wood is too wide…the string keeps catching…	Inferring Hypothesising Exploratory Reasoning Judgement	Analysing Diagnosing Speculating Volunteers information Assessing the situation	Charlotte makes her observations and is thinking aloud.	There is questioning as to why it is not working as expected and a speculative comment
Simon	we can't cut it…make it too weak…I know…how about a drawing pin in there…tie the string to it	Experiential Exploratory Reasoning Imaginative Heuristic Organising Judgemental	Thinking it through Using prior knowledge of materials Using imagination Problem solving Purposeful behaviour	Simon initiates a helpful suggestion based on a personal knowledge of materials… Shows imaginative thinking.	Surprise idea from Simon…using a drawing pin is a real possibility… A solution is now emerging.

An analysis of peer interaction during a problem solving task.