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So We’re Going to Have This Huge Spike Here? Pupils’ Talk While Designing and Making
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Abstract
This paper reports on the conversations between focal pupils (two boys aged 13 years), as they collaborated in the designing and making of a statue of a fierce creature that would be used to deter intruders from their classroom. This dialogue is analysed from two perspectives: (a) that of exploratory talk (Barnes & Todd, 1977) and (b) dialogic talk (Alexander, 2004). The analysis revealed that the pupils (a) made design decisions concurrently with making, (b) did not, for the most part, engage in exploratory talk, and (c) did engage in dialogue. The analysis also revealed the designerly nature of the talk that did take place and raises some questions as to the purpose of pupil talk during designing and making. The paper concludes with some suggestions for further questions to investigate with regard to the purpose and nature of talk in design & technology lessons.

Key words
design decisions, collaboration, pupil-pupil talk, elementary

Introduction
When pupils solve a problem together, that is, they collaborate, they advance more in their understanding of it than they do when they work alone (Kruger, 1993). Hennessy and Murphy (1999) define the term “collaboration” as:

Pupils actively communicating and working together to produce a single outcome, talking and sharing their cognitive resources to establish joint goals and referents, to make joint decisions, to solve emerging problems, to construct and modify solutions and to evaluate the outcomes through dialogue and action. (p. 1)

Central to this definition is pupil talk. Hence, if designing is seen as a form of problem solving, and a central aspect of designing is making design decisions (Barlex, 2005), then it is reasonable to suggest that pupils’ ability to make design decisions would be enhanced by engaging in what Barnes and Todd (1977) have labelled “exploratory talk” (p. 3). Mercer, Wegerif, and Dawes (1999) have defined exploratory talk as:

[Talk] in which partners engage critically but constructively with each other’s ideas. Statements and suggestions are sought and offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered. In exploratory talk, knowledge is made publicly accountable and reasoning is visible in the talk [authors’ italics]. (p. 97)

Alexander (2006) has also argued convincingly for the importance of classroom talk that is based on dialogue. He notes that, “children, we now know, need to talk ...in order to think and learn ...talk is arguably the true foundation of learning” (p. 9). Alexander also argues that it is not only dialogue between the teacher and pupil that is important, but also that dialogue between pupil and pupil has an essential part to play in learning.

This paper is in four parts. First, it will review a sample of the literature describing both the theoretical and empirical evidence that supports the centrality of talk in learning. Second, the paper reports the results of a study that addressed the question: To what extent do two Grade 8 boys (age 13-14), working in a single sex dyad, engage in exploratory talk or dialogue as they design and make a product in response to a teacher-generated design brief. This study is seen by the authors as a tentative first step, a toe-in-the-water, toward the establishment of a larger study that will investigate the nature of talk between collaborating pupils and how this talk might be improved in terms of its effectiveness in helping pupils make design decisions. The third section of the paper will report some results of an analysis of data derived from verbatim transcripts of the talk between the two focal pupils: (a) that these pupils made design decisions concurrently with making, (b) that these pupils did not, for the most part, engage in exploratory talk, and (c) they did engage in dialogue. Finally, the paper will report some of the issues and possible research questions arising from this pilot.
Review Of Literature

In their now seminal work that investigated and described pupils’ talk when working in small groups, Barnes and Todd (1977) stated:

It is ...a collective relationship that we observed in our small group discussions. Members were free to shift the topic, to try out new formulations and to explore alternatives, since none of the questions asked concealed positional claims to impose a frame on the discussion to guide its direction or to judge the relevance of answers. The members of our groups cast their bread upon the waters. They were each others’ [sic] resources and most of their utterances were contributions to thinking. (p. 126-127)

The notion that talking is central to learning has a long history. Piaget (1932) proposed that cognitive conflict was central to development. When peer interaction results in conflict of egocentric but equally valid points of view, disequilibrium develops in the mind of the child. As a result, the child is required to take another perspective into account and to use reasoning to resolve the contradictions and integrate new perspectives. Piaget asserted that this process of conflict and resolution is crucial to cognitive growth.

In contrast to Piaget’s view of development through disequilibrium, Vygotsky (1978, 1934/1986) hypothesised that learning is a social phenomenon in which speech (talk) plays a central role. Within this socio-constructivist framework, learning occurs through collaboration and participation in a community of learners and practices (Ligoro, Talamo, & Pontecorvo, 2005). Learning is made possible only through social interaction aimed at collaboration.

Krugér (1993) has argued that regardless of whether one adopts a socio-cognitive conflict or social constructivist perspective, the important factors affecting the degree of mutual engagement (and thus learning) are that pupils: (a) are working at the level of ideas; (b) are finding errors, finding differences, agreeing to disagree; and (c) are communicating their ideas to one another, making discoveries about what works, and creating a good solution. Berkowitz, Gibbs, and Broughton (1980) referred to these as elements of transactive communication, reflected in the amounts of explanations, justifications, clarifications, resolved conflicts, and elaborations of ideas produced by pupils working together.

A significant body of empirical evidence also supports the centrality of talk to learning (see, for example, Alexander, 2006; Mercer, Wegerif, & Dawes, 1999). Miell & MacDonald (2000) found that a key feature impacting the nature of pupils’ collaboration is the degree of engagement with each other’s ideas and perspectives that the pupils are able to establish and maintain through talk. In a study that investigated how pupils can be helped to use language to learn science, Mercer, Dawes, Wegerif and Sanms (2004) found that pupils can be taught to use “exploratory talk” (p. 360) as a tool for reasoning and that talk-based activities can function in scaffolding the development of reasoning and scientific understanding.

According to Mercer, Wegerif and Dawes (1999) engaging pupils in exploratory talk requires a set of seven ground rules:

(a) All relevant information is shared, (b) the group seeks to reach agreement, (c) the group takes responsibility for decisions, (d) reasons are expected, (e) challenges are expected, (f) alternatives are discussed before a decision is taken, and (g) all in the group are encouraged to speak to other group members. (pp. 98-99)

Alexander (2006) has developed a repertoire of learning talk that includes “analyse and solve problems, speculate and imagine, explore and evaluate ideas” (p. 39). These types of talk are crucial if pupils are to be able to articulate their design decisions.

The next section of this paper describes an exploratory study that investigated the extent to which pupils engaged in dialogue and, although untutored in the “ground rules”, the extent to which they engaged in exploratory talk as they designed and made a product in response to a design brief.

Method

The data reported in this paper are derived from Year 3 of a three-year program of research that investigated how students learn to make design decisions. Participants were one class of students (16 girls and 10 boys) attending a small Catholic elementary school in Eastern Ontario. These students were tracked to determine their emerging ability to make design decisions as they progressed through Grades 6–8. Selection of this school was a case of convenience sampling, the principal of the school being well known to one of the authors and having, in the past, shown a willingness to involve his staff and pupils in research studies (Welch, Barlex, & O’Donnell, 2006).

Four focal pupils, two boys and two girls, were purposefully sampled from the class using the following criteria: (a) of average or above average intelligence based on prior classroom performance, (b) articulate, and (c) able to work together. These four pupils were investigated each time data was collected and were anticipated to provide “information-rich cases for study in depth” (Patton, 2002, p. 169) about their ability to make design decisions.
In Year 3, pupils were given the following design brief: Design and make a large statue of a creature that can be friendly (and welcome visitors to a classroom during the day) or fierce (and deter intruders to a classroom after dark). This task met the statutory requirements of the Ontario Curriculum (Ontario Ministry of Education, 1998), which requires pupils to study structures. The task has also shown, in previous use by the authors as both an elementary classroom activity and as a focus for professional development, that it enables a wide range of creative responses by pupils. It allows for the four characteristics of creative processes identified by Robinson (1999): (a) involves thinking imaginatively, (b) involves purposeful activity, (c) permits the generation of something original, and (d) results in an outcome of value.

The pupils were taught knowledge and skill likely to be useful in tackling this design brief through a series of Support Tasks, that considered (a) fierce and friendly expression, (b) analysis of animal structure in terms of simple stick figures, and (c) the designing and making of a small creature statue from card squares.

The response of the two focal pupils is shown in Figure 1. It is completely different in concept to the creature statues produced by the rest of the class, most of which were based on four legged dinosaurs. It is in the form of a serpent, approximately three metres in length and undoubtedly fierce.

Analysis of data first required the verbatim transcription of audio recordings of the naturally occurring talk between the two pupils. To increase intelligibility, punctuation was added to the transcript. Next, the transcript was segmented into "speech bursts" or chunks (Miles & Huberman, 1994, p. 56). A speech burst was defined as a complete portion of text uttered by a pupil without interruption from that pupil’s partner. Next, a description of the pupil’s actions was added to the right of each segment or series of segments. These provided a context for the pupils’ talk.

The pupils’ talk was analysed in two ways. First, those utterances concerned with making design decisions were identified. These were coded using the five categories of design decisions identified by Barlex (2005). Second, these utterances were examined to determine whether or not they involved the “ground rules” of exploratory talk (Mercer, Wegerif, & Dawes, 1999) or the repertoire of learning talk as described by Alexander (2006). This part of the analysis involved the qualitative methods of discourse analysis, which “rely essentially on the interpretative analysis of transcribed speech” (Wegerif & Mercer, 1997, p. 271).

Results
Making design decisions
Barlex (2005) has suggested that in the context of school-based designing, students should be given the opportunity to make five types of interrelated design decisions: (a) conceptual, (b) marketing, (c) technical, (d) aesthetic, and (e) constructional. Conceptual decisions are concerned with the overall purpose of the design, that is, what sort of product it will it be. Marketing decisions are concerned with, for example, who the design is for, where will it be used, and where will it be sold. Technical decisions are concerned with how the design will work. Aesthetic decisions are concerned with what the design will look like. Constructional decisions are concerned with how the design will be put together.

Analysis of the transcripts reveals that the vast majority of the design decisions made by the pupils were concerned with aesthetics and construction, although there was a brief discussion concerning the technical issue of achieving balance. The dominance of aesthetic and constructional decisions is clearly a function of the design brief.

While space limitations do not allow for a full reporting of the data and our analysis, the following extracts of the transcript are typical. For example, at the beginning of their discussions while seated at a large flat table in the classroom area, the pupils agreed that, in response to the design brief, their creature would be fierce not friendly. Using markers and a large sheet of paper, they began to draw while simultaneously continuing to talk:

Iain: [We could] make it a fierce.
Jesse: Yeah.
Iain: Like spikes, then like kind of huge spikes on his head or something or maybe like small spikes here on his...
tail. You know what not a spike on his head, a huge spike on his tail.

Jesse Okay.
Iain On the end of his tail.
Jesse And it’s a water creature still?
Iain Yes.

Following a period of exploring the general shape of the creature, discussion turns to the tail:

Jesse It has to ...like tail up, it goes, okay here let me draw it.
Iain Okay, oh it goes down, then tail.
Jesse Tail, up, down, up, long down, up, side, down, straight up, ...there’s a fin here and a fin here, see.
Iain Okay.
Jesse And his tail is really long.
Iain We are so totally getting this.
Jesse And here, let me get a blue [marker] to draw the joints.

Shortly thereafter, discussion turns to adding spikes to make the creature look fierce:

Jesse So, we’re going to have this huge spike here?
Iain Yes.
Jesse What like multi-spikes?
Iain No, single, it’ll be like a poison point sort of.
Jesse Like so?
Iain Yeah.
Jesse Or should we have it like this? Like this, like a dragon.

The drawing that they produced collaboratively is shown in Figure 2.

This point the pupils decide that they are ready to begin construction of the creature. They move from the table in the classroom to the workshop bench, where they begin to assemble the tools they think they will need:

Jesse Oh and I’ll get the safety rulers. Don’t forget your scissors.
Iain And my pencil.
Jesse Here we go, we need these [picks up a metre rule and a tool to crease corrugated cardboard]. Okay we’re looking at this. Should we start with fins?
Iain I didn’t start with fins here.
Jesse We have to like cut stuff out. We’ll just start it small and then just build up.

Iain I’ll start creasing these.
Jesse Okay.
Iain So we’ll need three of these.
Jesse Three of what?
Iain Three of the medium ones.
Jesse On the tail?
Iain Hmm, hmm.
Jesse Okay, and then we’ll just go into the big one?
Iain And then we’ll go into the body.
The pupils continue to make constructional design decisions:

Jesse  We could put more butterfly clips here.
[Note that throughout the transcripts, the boys refer to “butterfly clips” rather than to “paper fasteners.”]
Iain  Hmm?
Jesse  We could put more butterfly clips here so it won’t move.
Iain  Yeah let’s do that.

Having constructed part of the tail, the talk becomes a to-and-froing between aesthetic and constructional decisions. Indeed, from this point on, the transcripts show that the conversation between the pupils is a constant merging of aesthetic and constructional design decisions. While they appeared to share a broad conception of the sort of creature they were designing, many decisions remained to be worked out as the making continued:

Iain  This is a pretty big tail.
Jesse  Should we add those other two small ones? Should we add those other two small ones? I think we should.
Iain  What?
Jesse  Those other two small ones that we had.
Iain  We can’t make it too big.
Jesse  What?
Iain  It’s moving still.
Jesse  Yeah but not as much as last time.
Iain  But not as much.
Jesse  We might need more clips. Yeah we’ll need more clips.

Pupils’ talk
To what extent do the verbatim transcripts of pupils’ talk manifest the characteristics of “exploratory talk” described by Mercer, Wegerif and Dawes (1999) and “learning talk” as described by Alexander (2006)? Once again, space limitations do not allow for a full reporting of the analysis, and so here we focus on two aspects. First, we focus on three of the ground rules listed above: (a) the group seeks to reach agreement, (b) reasons are expected, and (c) alternatives are discussed before a decision is taken. Second, we focus on the repertoire of learning talk identified by Alexander (2006) which includes (a) analysis and problem solving, (b) speculation and imagination, and (c) exploration and evaluation of ideas.

The transcripts show that the two boys seek to reach agreement. For example, when Jesse notes that at one point the structure is weak (requiring a constructional design decision), he suggests that “we could put more butterfly clips here.” Iain at first does not respond, but when Jesse repeats the suggestion Iain looks more closely at their work before agreeing: “Yeah, let’s do that.” This pattern of suggestion-agreement is evident throughout the transcript.

In order to elicit the reason why either an aesthetic or constructional design decisions is being proffered, one of the boys must first ask the question: “What do you think?” and, having received a response, ask a further question: “Why do you think that?” At no point in the transcripts does this sequence occur. In other words, the boys do not either ask for or provide reasons for making a design decision and offering a possible solution. Hence, a critical aspect of exploratory talk is missing.

Rather, the nature of their talk is typified by an utterance by Jesse, who asks Iain for an opinion on a constructional design decision: “Should we start with fins?” Throughout the transcripts, the approach followed by the boys is to (a) suggest an idea and (b) wait for a response (usually agreement) from his partner. Although this approach does offer opportunity for peers to ask the question, “Why do you think that?” this does not happen. There is some discussion of alternatives before a decision is taken. For example, while using sketches to make aesthetic design decisions, Jesse suggests, “So, we’re going to have this huge spike here?” Iain agrees, but Jesse expands his idea by saying “What, like multi-spikes?” There is a pause before Iain responds with “No, single, it’ll be like a poison point sort of.” Once again, no reasons for this design decision are sought or offered.

The two pupils exhibit all three of Alexander’s repertoire of learning talk. For example, the following utterances reveal problem solving and analysis: Jesse said, “We could put more butterfly clips here. …We could put more butterfly clips here so it won’t move.” To which Iain replied: “Yeah let’s do that.”

The two pupils begin to engage in speculative and imaginative learning talk when Jesse says: “It has to …like tail up, it goes, Okay here let me draw it.” And Iain replies: “Okay, oh it goes down, then tail.” Jesse then says: “Tail, up, down, up, long down, up, side, down, straight up, …there’s a fin here and a fin here, see.” To which Iain agrees, saying: “Okay” with Jesse then saying, “And his tail is really long.”

Finally the pupils explore and evaluate their ideas as evidenced in the following segment of dialogue. Iain begins by saying: “This is a pretty big tail. Jesse replies: “Should we add those other two small ones? Should we add those other two small ones? I think we should.” Iain then says: “What?” to which Jesse replies: “Those other two small ones that we had.” And Iain says: “We can’t make it too big.”
Discussion and conclusions

The roots of this paper lie in the authors' observations during data collection sessions in elementary classrooms and subsequently reading the transcripts of pupils' talk while they are working in single sex dyads. We have noted, like other researchers, that this talk is frequently uncooperative, off-task, inequitable, and ultimately unproductive (Mercer, Dawes, Wegerif, & Sams, 2004; Welch & Barlex, 2008). However, in this case the talk was almost exclusively on task and enabled the pupils to collaborate successfully in developing a highly creative solution to the design brief. John-Steiner (2000) refers to a “growing body of evidence that learning and thinking is a social process,” (p. 3) and that a careful scrutiny of how knowledge is constructed reveals “the interdependence of thinkers in the co-construction of knowledge” (p. 3). In the context of collaboration between elementary school pupils, Rojas-Drummond, Mazon, Fernandez and Wegerif, (2006) note that, “knowledge can be conceptualised as the product of the joint negotiation of the participants to make sense of a given situation, using a variety of communication strategies to construct a shared understanding” (p. 84).

So in considering this case we need to ask: “What shared knowledge is being constructed by the collaboration of these pupils?” The shared knowledge is the nature of the creature they are conceptualising and creating. Much of this was done by means of collaborative drawing and this developed before their eyes an image with which they were both comfortable and in agreement. As Iain said, “We are so totally getting this.”

Mercer, Dawes, Wegerif, and Sams (2004) argue that pupils need to be taught, and to learn, how to engage in exploratory talk and to use it to enquire, reason, consider information together, to share and negotiate their ideas, and to make joint decisions. But we have to ask: “To what extent would the outcome of this designing and making be improved if these pupils had engaged in exploratory talk in which they each contested the ideas put forward by their partner?” In this case, it appears that the pupils were in considerable agreement about the nature of their creature and such contestation would have been inappropriate and perhaps counterproductive. They were each willing to accept the ideas put forward by the other as they proceeded. Much of the talk is almost consensual thinking aloud. They conceptualised their creature through initial collaborative sketching and were working towards its realisation in considerable harmony, as indicated by the similarity between their original sketch and the remarkable final fierce creature. It is significant that they met three of the requirements of learning talk as described by Alexander (2006) and this perhaps indicates that collaborative designing should be encouraged if we want pupils to learn through design activity. This does, of course, raise questions about assessment.

In the case described here, exploratory talk of the kind advocated by various authors (Barnes & Todd, 1977; Mercer, 1995, 2008; Mercer, Wegerif, & Dawes, 1999; Rojas-Drummond, Mazon, Fernandez, & Wegerif, 2006) may not have been beneficial. Yet the idea of pupils being able to make better design decisions through the use of exploratory talk is tantalising and worthy of further consideration. Mercer, Dawes, Wegerif and Sams (2004) demonstrated that an experimental teaching program enabled elementary school pupils to (a) work together more effectively, (b) improve their language and reasoning skills, and (c) reach higher levels of attainment in their study of science. However, we need to be cautious, because the study of science does not have the same educational intentions as technology education. But in teaching pupils to make design decisions, a key element in technology education, explicit teaching of exploratory talk dedicated to such activity might pay dividends. Hence the results of this exploratory study raise, at least in the minds of the authors of this paper, two sets of questions that could form the basis for future research. The first set is concerned with exploratory talk: To what extent would pupils’ ability to engage in exploratory talk enhance their ability to make design decisions? In what ways would pupils’ engagement in exploratory talk change their design decisions? How can pupils in design and technology classrooms be taught to use the ground rules of exploratory talk? The second set of questions is concerned with learning talk: How do we enable pupils to engage in dialogue that meets Alexander’s requirements for learning talk? To what extent and in what ways would this enhance their ability to make design decisions?

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