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## Thinking, Interthinking, and Technological Tools

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### Abstract/Summary

Language use is widely regarded as an important indicator of high quality learning and reasoning ability. Yet this masks an irony: language is fundamentally a social, collaborative tool, yet despite the widespread recognition of its importance in relation to learning, the role of dialogue is undervalued in learning contexts. In this chapter we argue that to see language as only a tool for individual thought presents a limited view of its transformative power. This power, we argue, lies in the ways in which dialogue is used to *interthink* – that is, to think together, to build knowledge co-constructively through our shared understanding. Technology can play an important role in resourcing thinking through the provision of information, and support to provide a space to think alone. It can moreover provide significant support for learners to build shared representations together, particularly through giving learners access to a wealth of ‘given’ inter-related texts which resource the co-construction of knowledge.

### Introduction: The development of individual and collective thinking



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### Diverse contexts for the potential of technology for thinking and interthinking

The pictures here will be familiar to most who have had any contact with educational settings in the last 20 or so years. Indeed, one of our most recent books (Littleton and Mercer 2013) reflected on one of the first pieces of research into school-classroom based dialogue from that time. There, it was noted that in many cases group work around computers was conducted not due to any underlying pedagogic strategy, but because of a lack of resources. For many this will be a familiar story, but along with colleagues, we have spent considerable effort in investigating what constitutes effective learning in group activity particularly that mediated by technological devices. Of course, many educators – as was the case in that original research – will have had the experience of frustration in some such situations, finding occasions when group work seemed to be ineffective and suspecting that a better use of resources would be to set students on individual tasks. Indeed, what is so potent about many new technologies is their ability to open up new worlds of learning for individuals. Yet, in this chapter we will argue that to see technology as primarily an *individual* pursuit is to miss out on two important considerations: firstly, many modern technologies vastly expand the potential for inter-textual and inter-active elements (Wegerif, 2013) through our interaction with which we are exposed to the thoughts and arguments of others and, secondly, technology can be an invaluable aid in resourcing and supporting both co-located and remote small group activity.

Throughout this chapter we aim to highlight the ways in which shared use of technology can be seen as both an individual and collective resource, and foreground the importance of dialogue as being of fundamental importance in such contexts.

## Language and Thinking

The Russian psychologist, Lev Vygotsky, highlighted the importance of language for thinking, emphasising that:

*... what children gain from their 'intermental' experience (communication between minds through social interaction) shapes their 'intramental' activity (the ways they think as individuals). What is more, he suggested that some of the most important influences on the development of thinking will come from the interaction between a learner and more knowledgeable, supportive members of their community. (Mercer, 2003, p.74)*

Building on this premise, one of us (Simon Knight) in earlier work on the importance of dialogue in the effective use of interactive white boards (IWB) noted that:

With respect to direct pedagogical functions (as opposed to social functions such as behaviour management), dialogue seems to serve several purposes:

1. supporting individuals' subject learning
2. supporting psychological development – the development of oral language and reasoning skills
3. promoting whole class and small group understanding or commonality
4. enabling sharing of ideas that can be improved together (both whole class and small group) – a purpose the IWB is particularly well placed to serve... ." (Knight, 2013b)

Traditionally educational researchers have been particularly interested in the first two of these concerns, regarding the effectiveness of group work for individual learning. Similarly, psychological research has tended to focus on the individual impact of social interaction on thinking and learning. The focus, then, has been on how collaboration changes individuals, as opposed to how collaboration might be an object of inquiry in its own right. The implication is that there are clear individual benefits to high quality dialogue; that taking individuals as the focus is not such a poor strategy in the analysis of classroom dialogue. Of course this will be of little surprise. When in conversation a person informs you of some fact, which you then use, some learning has taken place. Moreover, when they demonstrate some linguistic method such as a particular argumentation structure, you may use that format to resource your own subsequent thinking. It is for this reason that in both philosophy and psychology there is an increasing interest in 'testimonial knowledge' – the knowledge we gain from other's testimony, largely through speech – and as Harris (2012) has noted, the trusting of what you are told is at least some of the time fundamental to the learning experience.

There is a parallel to this focus on learning directly from others, in the use of technology in the classroom. When teachers stand at the front of classrooms and provide students with information, or warn them of dangers in science experiments and so on we expect students to trust that information. Similarly, when we ask students to engage in research, using books and increasingly the internet, we hope that they will use their critical skills to engage with some of the information that they find. High quality dialogue, then, could simply be an enhanced version of this type of exchange; the appropriation of claims from reliable informants.

Much group work takes this individualistic level of analysis as its focus. For example, this notion of information exchange has sometimes been termed 'transactivity' which has in some circumstances been operationalised at an individualistic level, with individuals placed into situations in which they have information required by other group members for the completion of some task. Indeed, much group work research takes this level of analysis as its focus – the individual, as opposed to the collaborative unit. This focus on individual activity in collaborative contexts in contrast to collaborative units is common to much group work research, for example Azmitia and Montgomery's (1993) analysis of information transmission via individual's explicit statements (rather than on the language used to co-construct). It is to this perspective on dialogue, as a co-constructive tool to interthink, that we turn in the next section.

## Interthinking

We began the preceding section by noting the significance of Vygotsky in our understanding of learning. However, as we note in the previous section, this view of the transmission of knowledge from experts to novices provides only one – albeit important – facet of the potential of dialogue for learning. There is now strong consensus that high quality educational dialogue among peers is associated with positive learning outcomes (see the collection edited by Littleton and Howe (2010)). Engaging children in extended talk which encourages them to ‘interthink’ and reason together in talk, impacts both their subject learning, and general reasoning skills (Dawes, Mercer, & Wegerif, 2004; Mercer, Dawes, Wegerif, & Sams, 2004; Mercer & Littleton, 2007; Mercer, Wegerif, & Dawes, 1999; Mercer & Sams, 2006; Rojas-Drummond, Littleton, Hernández, & Zúñiga, 2010) as well as their social and language skills (Wegerif, Littleton, Dawes, Mercer, & Rowe, 2004).

However, a common concern in computer based tasks, is that the shared nature of the resource may reduce the need for children to talk and articulate their knowledge explicitly. This suggests the need for task-based studies which explore the ways that discourse is used (Clark & Brennan, 1991; Pickering & Garrod, 2004). Indeed “some problems that learners may encounter in Computer Supported Collaborative Learning (CSCL) environments seem to be enhanced in these contexts, for example, due a lack of social presence or limited nonverbal cues such as gestures and facial expressions (Daft & Lengel, 1986; Kreijns, Kirschner, & Jochems, 2003; Short, Williams, & Christie, 1976)” (Janssen & Bodemer, 2013, p. 40).

Partly in response to such concerns, Mercer and colleagues have extensively researched what constitutes effective educational dialogue, including in CSCL contexts. They have developed an intervention strategy called ‘Thinking Together’ designed to explicitly teach, children how to engage in constructive dialogue in classroom contexts through the teaching of particular types of talk, and the use of pedagogic strategies such as generating and establishing ‘ground rules’ for talk designed to foster effective group work<sup>1</sup>. The team have highlighted a particular form of productive dialogue which, adapting the term from Douglas Barnes’ (Barnes & Todd, 1977) original broadly individualistic description, they have termed ‘exploratory’. They contrast this with two other types of, typically less productive, talk – disputational, and cumulative, as in

Table 1.

**Table 1 Mercer and Colleagues’ Typology of Talk\***

Type of Talk	Characteristics	Analysis
Disputational	“Characterised by disagreement and individualised decision making. There are few attempts to pool resources, to offer constructive criticism or make suggestions.”	“short exchanges, consisting of assertions and challenges or counter-assertions (‘Yes it is.’ ‘No it’s not!’).”
Cumulative	“Speakers build positively but uncritically on what the others have said. Partners use talk to construct ‘common knowledge’ by accumulation.”	“Cumulative discourse is characterized by repetitions, confirmations and elaborations.”
Exploratory	“Partners engage critically but constructively with each other’s ideas. Statements and suggestions are offered for joint consideration. These may be challenged and counter-challenged, but challenges are justified and alternative hypotheses are offered. Partners all actively participate, and opinions are sought and considered before decisions are jointly made. Compared with the other two types, in exploratory talk knowledge is made more publicly accountable and reasoning is more visible in the talk.”	Explanatory terms and phrases more common – for example, ‘I think’ ‘because/’cause’, ‘if’, ‘for example’, ‘also’

\*(Adapted from Mercer and Littleton 2007, pp. 58–59)

<sup>1</sup> See the Thinking Together materials hosted at the University of Cambridge <http://thinkingtogether.educ.cam.ac.uk/>

Other researchers have offered similar characterisations of educationally productive dialogue. For example, 'Accountable Talk' (see Michaels, O'Connor, Hall, & Resnick, 2002; Resnick, 2001) has been described as encompassing three broad characteristics:

1. accountability to the learning community - in which participants listen to and build their contributions in response to those of others;
2. accountability to accepted standards of reasoning, talk that emphasizes logical connections and the drawing of reasonable conclusions; and,
3. accountability to knowledge, talk that is based explicitly on facts, written texts, or other public information. (Michaels, O'Connor, & Resnick, 2008, p. 283)

As with the typology of talk developed by Mercer and colleagues, the emphasis of Accountable Talk is on learning to engage constructively, yet critically, with other's ideas, and in so doing develop and use the skills of explanation and reasoning - learning to use language as a tool for thinking together rather than focusing solely on learning particular subject or topic knowledge. Thus, while the individualistic focus of much psychology research may initially have appeared reasonable, it seems less appropriate given closer scrutiny. In many cases problem solving and learning more generally involves deploying the resources around you - including the minds' of other people. Indeed, learning and teaching are fundamentally communicative acts; as we noted, this claim is receiving renewed focus in both philosophy and psychology (see for example, Fricker, 2012; Haddock, Millar, & Pritchard, 2010; Lackey & Sosa, 2006; Lackey, 2008) and their analysis of 'testimonial knowledge', the role of as Harris puts it "trusting what you're told" (Harris, 2012), but simple *appropriation* of claims will not do. This highlights the significance of dialogue in learning. Wherever education is taking place, commonality - a shared perspective - is imperative, and dialogue is the tool used to co-create and constitute such a perspective (Edwards & Mercer, 1987). Furthermore, the dialogue used to create 'common knowledge' is related to the educational development of children.

Recently Littleton and Mercer (Littleton & Mercer, 2013) consider the complexity of common knowledge context as both historical and dynamic :

Successful interthinking requires partners to have, and to develop, a foundation of common knowledge to underpin their discussions. We have distinguished two types of common knowledge, both of which can be important. The first of these is accumulated through the activities of a group, as members develop a shared history. They have knowledge in common because it has been generated by their joint activities and associated conversations. It is the kind of common knowledge which allows a teacher to refer only briefly to the content of a previous lesson and expect students to have some recollection what it had been about. We have called this dynamic common knowledge, because it is produced by the dynamics of the group's own extended activity. The second type, which we call background common knowledge, is that which any established member of a community of practice can take for granted as being shared with other members and does not therefore need to be explained from first principles. (p 112)

Language is thus an important cultural tool. Even if we disagree with particular claims, our shared language allows us to draw upon our common knowledge as a resource for interthinking. Technologies, including books, afford grounding for this resourcing of our dialogue. Thus, through the use of technology, we are able to draw on the voices of others across time and space (Wegerif, 2013). It is for this reason that the transmissive view of language and technology use described above offers only a partial perspective on the potential of language: our capacity to interthink is fundamental to our capacity to engage with the ideas of others.

### Technological Tools

We invite the reader to return to the images presented at the beginning of this chapter, or indeed to consider any number of other scenarios: children sat next to each other but not working together;

squabbling over control of the keyboard; children communicating via text remotely; the posting of comments on blogs and status updates, and so on.

Our reason for raising these examples is not to highlight the randomness with which technological use will be of success. Rather, it is to foreground that many technologies fit seamlessly into our everyday practices, technologies afford opportunities for particular types of interaction, but the contexts in which they are used (including classroom task) are of fundamental importance. In all cases, it is interesting to think about the individual and collective benefits of technology use; for example, many tools facilitate the division of labour on tasks, and such facilitation may be productive both for a shared goal and for the individuals engaged. However, such examples do not facilitate the kind of 'interthinking' to which we refer above. In contrast, some tools, through their reification of participation are more facilitative of co-constructive processes.

Considering technology as anything other than "tool-mediated social practices" (Cole & Derry, 2005, p. 210) is problematic. We do not doubt the transformative power of many technologies – indeed, we note that such transformation is common through human history – however, we wish to highlight that technologies do not exist in a socio-cultural vacuum. Hype around many of these technologies is problematic, and can distract from the scrutiny of the quality of learning, and interaction when using such tools. We now discuss some specific examples of tool use, highlighting their relevance to both individual thinking and interthinking. In particular, we draw the reader's attention to the ways in which people engage in co-constructing representations, *and* the ways in which representations are resourced by co-constructed representations through their engagement with background common knowledge. The examples are intended to exemplify the kinds of interactions with the ideas of others that learners engage in through the use of technologies, of course, there are many more such examples, and one of our claims here is that the boundary between using background common knowledge, and engaging in co-construction of representations is not firm; interthinking, working with the ideas of others, inevitably involves building on a shared *background*, and *dynamic* common knowledge.

#### **Dynamic common knowledge: co-construction of representations**

The seeking of information is a classic example in which the benefits of the activity appear to be entirely conferred on the individual. We seek information because we (as individuals) wish to know something. Indeed, this appears to be a direct analogue of question-answer exchanges. In a sense this is true, however, as that analogue indicates, there are at least two ways in which information seeking goes beyond individuals. First, much information seeking can be seen in the context of larger discussions than simple question and answer exchanges (and of course, information can flow in both directions in such exchanges). Secondly, when we seek information, particularly on the web, we engage with a network of linked documents with a rich set of intertextual ties; in a very real sense, reading much of the web involves an interaction with the thoughts of many people, through blog and micro-blog posts, videos, and images, all of which "readers" may comment on.

This example is in fact particularly interesting because, unfortunately children in particular are rather poor at the use of search engines, and this paucity appears to be only marginally related to their lack of technological skill. This lack of skill has led one researcher who explored collaborative information seeking in educational settings to suggest that teenagers may be, "largely unable to select appropriate search strategies (planning), check their progress (monitoring) and assess the relevance of search outcomes (evaluating)." (Lazonder, 2005, p. 466). In that research, on how pairs of teens searched for information together, Lazonder was interested in the effect of collaboration on this "inert knowledge problem" (Lazonder, 2005, p. 466). Lazonder's suggestion was that through the use of verbalisation learners might improve their self-regulatory processes, prompting users into better negotiating the search process. Indeed, in this example from a sample of 20 students with a mean age of 20, Lazonder found that pairs did perform better, and faster, than individuals. They also used more varied search strategies and evaluated websites marginally better than the individuals.

This example can be read in two ways; the first (suggested by Lazonder) implicates the second of the dialogue purposes noted above – that language can facilitate individual psychological development. However, a second interpretation is motivated by our understanding of interthinking. This interpretation implicates the role of effective collaborative dialogue in the co-construction of shared knowledge. Indeed, one of us (Knight, 2013c) has noted that the possible association between more advanced epistemic working and exploratory or dialogic dialogue (Reznitskaya & Gregory, 2013) has direct implications for information seeking contexts in which our evaluation skills (fundamentally epistemic in nature) are utilised. Indeed, in earlier work (Knight & Mercer, Forthcoming; Knight, 2012) one of us (SK) has explored precisely this relationship between collaborative classroom dialogue and search based tasks. In that work, despite generally similar academic attainment, the success of the small number of groups appeared to be directly related to their ability to use the kind of exploratory dialogue described above. In that work we noted that the least successful group also engaged in the least exploratory talk, as well as reflecting very little on the relationship between the information they found and the purpose for which they were seeking it. Indeed, that group appeared to be primarily concerned with the quantity, ease of access, and aesthetic value of information. In contrast the other two groups focussed on the ‘importance’ of information and particularly that information was ‘explained’; and the detail and novelty of information, respectively. The point here is not to suggest that individual learning does not take place in information seeking tasks. Rather, it is to highlight that such tasks can involve a range of levels of work – and that at times it might be appropriate to set information seeking tasks that involve *interthinking*. To draw an analogy, just as whole class questioning can involve a range of question types (including open or closed, and those aligned at a stage on the popular Bloom’s Taxonomy (Bloom, 1956)) so too can search tasks.

In search tasks, then, there is potential in thinking about open questions, and considering the ways in which questions should be broken down into components to understand how one question might lead to another (“What is the name today of the town where the founder of the Boy Scouts of America was born?”). Indeed, the seeking of information is a prime context for the promotion of dialogue to explore misconceptions, discuss evaluation of results, and sharing of strategies<sup>2</sup>. Of course, searching for information also involves identification with other points of view – representations of knowledge which are ‘given’, and served up through the search engine – and we turn to this now.

#### **Background common knowledge: co-constructed representations**

Orientation to other’s points of view, as we search the internet, talk to peers, read books, and so on is an important part of the learning process. In engaging in such activity we work with ‘given’ knowledge, representations that can be shared, and form a part of our common knowledge. With such resources we can engage in a rich history of ideas, and use ‘co-constructed representations’ to engage in the ‘co-construction’ of representations.

The field of CSCL has a particular interest in this kind of ‘knowledge building’ (Scardamalia & Bereiter, 2003, 2006), the ways in which background common knowledge can effectively resource the co-construction of dynamic common knowledge through the use of representational tools. Thus, much work in CSCL has focused on developing environments that support particular types of efficacious dialogue. As we discuss below, there is evidence that suggests that CSCL representations used to resource collaborative group work, and mediate interactions with common knowledge, have a significant role to play in mediating effective group dialogue. However, we note that although such environments play an important role, types of productive dialogue which bear striking resemblance to those in our own work are not ‘automatically’ produced in the use of structured environments (see for example, Vries, Lund and Baker 2002). Moreover, Dillenbourg (2002) notes that some CSCL environments risk ‘over structuring’ with the consequence being that they restrict the use of educationally productive types of dialogue. So whilst design may reduce some difficulties (for example, by introducing threading to discussions) context is fundamental to understanding the

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<sup>2</sup>The first author has written some teacher notes on this point, available (under a Creative Commons licence) here <http://sjknight.com/finding-knowledge/edusearch-tips/> and in abridged form published (Knight, 2013a).

dynamic features of dialogue through which learning is co-constructed. Computer environments may be seen as complementary to such dialogue, in particular where they embody some of the systems through which exploratory and accountable talk are more likely to occur – the ‘ground rules’ of each.

Work has thus focussed on the ways in which the provision of a shared set of representations may support the development of productive dialogue, and the co-construction of further representations. Building on earlier work (Suthers & Hundhausen, 2003; Suthers, 2006), Suthers (2008) reports on three possible influences of CSCL representations on collaborative processes:

1. Negotiation potentials – because the representation is shared, participants feel obliged to negotiate over changes to it
2. Referential Resource – because the representation has shared history, it becomes imbued with meanings
3. Mutual Awareness – Because the representation is external, it is a shared resource which creates a shared frame for activity

With respect to the third point above, in a review of the literature on awareness in CSCL, Janssen and Bodemer (2013) note the importance of both content and social (or relational) group awareness – with the former relating to aspects such as awareness of knowledge states while the latter relates to the quality of collaborative processes. This is of particular interest given the concern raised that too much CSCL research has focussed on information sharing (between learners exchanging ‘facts’), at the cost of analysing the interactional conditions for learning, despite the fact that informational sharing is not a good predictor of collaborative performance (Suthers, Medina, Vatrappu, & Dwyer, 2007; Suthers, Vatrappu, Medina, & Dwyer, 2007, 2007; Suthers, Vatrappu, Medina, Joseph, & Dwyer, 2007).

In those studies, Suthers et al., note that despite one group outperforming another on knowledge construction involving the integration of multiple sources, those groups appeared not to share any more information (as indicated by individual referencing in an essay) and that their performance was best associated with ‘interaction’, as characterised by ‘round trips’ of information. These ‘round trips’ describe the reuse of information previously stated, the building of ideas between collaborators – perhaps the *interthinking* of collaborators using and developing shared artefacts. Building on work by Wells (1999) Twiner (Twiner, Littleton, Coffin, & Whitelock, 2014; Twiner, 2011) has suggested that such artefacts can function as ‘digital improvable objects’ – providing a cumulative basis of common knowledge upon which future discussions and other activities can draw and progressively build. Thus, the ways in which existing representations – the ‘co-constructed’ of our section heading – are used in the resourcing of co-construction is an important consideration.

## Conclusion

We have shown that the use of various kinds of digital tools, whether a shared display such as interactive whiteboard, an asynchronous chat tool, or the various kinds of social media and their facilities for commenting and sharing, can provide some valuable support for productive discussion. The ways in which technologies support access to representations, and the co-construction of representations, provides important support for not only thinking, but interthinking. Such representations and technologies can resource what Wegerif (2007; 2010) has called a ‘dialogic space’ in which different ideas, perspectives and understandings can be collectively explored, and material can be modified to record the development of a discussion and capture emerging ideas.

Wegerif’s (2010) claim is that, for a dialogic use of technology, we should consider:

1. Opening dialogic spaces (e.g. by adding comments to blogs), but also teaching to do this (e.g. through the use of ground rules for talk, and philosophy for children)
2. Widening dialogic spaces – understanding more points of view, and the background behind them, for example through WebQuest activities in which different perspectives – and their assumptions – are explored



3. Deepening dialogic spaces – increasing reflection on assumptions made in arguments by students and others, shared awareness tools to make explicit the arguments being made (and their structures) can support such deepening.
4. Teaching content through induction into fields of dialogue – Wegerif notes “interactivity makes it easy for software to simulate multiple points of view in a dialogue, thus allowing learners to be inducted into a field of dialogue rather than into fixed ‘truths’” (Wegerif, 2010, p. 350) noting that, the internet can be a cacophony of voices, rather than a dialogue, but through designed spaces – such as WebQuests, and the emailing of links between geographically distant groups – presence and dialogue can be mediated to encourage reflection and learning.

This final point is not only a claim about collaborative dialogue, but one about the very nature – the unstructured, messy nature – of the internet, and its use for developing space to explore multiple viewpoints. Crucially, if our targets are higher level reflection and conceptual understanding, such space must be created in contrast to many current educational systems, reiterating the point that collaborative task context is as important as collaborative tool design (Rick & Guzdial, 2006). Importantly, this highlights the need to consider the use of technology in context, and not just the design of technology itself.

The “interpretative flexibility” of technologies is important. When we observe or deploy technologies we should consider the particular social setting, and be mindful of not falling into the trap of technological determinism (Hamilton & Feenberg, 2005). Expectations for the transformative power of technologies should be mitigated by an understanding of the place of technology in the wider social system (Crook & Lewthwaite, 2010), which dialogue plays a fundamental role in and consideration of the kinds of interaction we are aiming for (Oliver, 2011).

Thus digital technologies offer opportunities for students to interthink online, and to do so without the constraints of time and location that arise in more conventional educational settings. However, we have also noted that any technology has its own limitations, and new technologies do not necessarily lead to improved learning outside of the context of high quality dialogue.

The conclusion we draw from research on technology and dialogue is that consideration should be given to the ways in which task, representation, and collaborative dialogue are brought to bear on learning. Working alone, and together, with or without technologies can confer benefits on individual thinking. However, the benefits of interthinking – and the facilitative role of technology in such activity – extend beyond this, offering opportunity for building new ideas together in ways that can be transformative.

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