Promoting thinking and conceptual change with
digital dialogue games

Andrew Ravenscroft
Learning Technology Research Institute (LTRI), London Metropolitan University, London, UK

Abstract
This paper will present a review of design-based research conducted over the past 10 years that has modeled and promoted students’ reasoning, conceptual change and argumentative dialogue processes and practices through designing a number of digital dialogue games. This line of work was inspired by some challenges and insights that emerged during projects dealing with conceptual change in science. Since then, the dialogical and pedagogical requirements for improved reasoning, knowledge development and conceptual understanding in a range of contexts have been addressed through projects that have designed and evaluated intelligent and highly interactive dialogue game tools, such as CoLLeGE (Computer-based Laboratory for Language Games in Education), AcademicTalk and InterLoc (Collaborative Interaction through scaffolding Locutions). This article will review this line of work through justifying and describing the rationale for its trajectory before presenting ongoing work that synthesizes and operationalizes its findings and insights. The ongoing work emphasizes an inclusive and personalized approach to learning dialogue that stimulates reasoning, collaborative thinking and the development of argumentative dialogue practices. This is arguably relevant to most learning contexts, and especially to contemporary science education. Finally, conclusions are drawn about the role of dialogue in learning in the digital age.

Keywords
argumentative practices, conceptual development, dialogue, reasoning.

Introduction
Dialogue is inextricably linked with thinking. Ravenscroft and Pilkington (2000) have argued that it is also well recognized that in many learning contexts, particularly in the sciences, students have alternative, everyday conceptions about the world – derived from their prior experience – that impede the development of improved understanding. Previous research has shown that these ‘alternative conceptions’ often require discussion and argumentation to bring about the belief revision and refinement of knowledge that leads to conceptual change and development (e.g. Pilkington & Parker-Jones 1996; Hartley 1998; Hartley & Ravenscroft 1999; Ravenscroft & Matheson 2002). These and similar studies have demonstrated that collaborative argumentation in which the tutor plays a facilitating inquiry and critiquing role, which in some respects is similar to a Socratic dialogue, is more effective than ‘conventional’ teaching in bringing about conceptual change.

Although there has been some debate about the precise form which dialogue should take to facilitate conceptual development, research that has adopted discourse analysis techniques (such as DISCOUNT, Pilkington 1999) has suggested how tutor–student talk can be effective. A range of studies (e.g. Pilkington et al. 1999; de Vincente et al. 1999) have shown that ‘successful’ exchanges are more likely to include questioning, clarifying, challenging and justification moves.
Similarly, where Wegerif (1996) and Mercer and Wegerif (1999) refer to ‘exploratory talk’, and others refer to argument or ‘constructive conflict’ (Kuhn et al. 1997); these sort of moves, or tactics, are frequently implicated as important. A more detailed analysis of the co-occurrence of these types of speech-acts and their position within exchanges has been able to suggest common strategies for directed lines of reasoning which tutors and students engage in (Katz 1997; Ravenscroft 2000).

**Designing dialogue for reasoning, belief revision and conceptual change**

Building on this discourse analysis work Ravenscroft and Pilkington (2000) developed the methodology of ‘investigation by design’ (hereafter IBD) to investigate educational dialogue and design models that support conceptual change and development. This approach combines discourse analysis and other formal dialogue game techniques to specify models that can be implemented as tools or modeling systems. These game designs and tools are developed through modeling key social and pragmatic level features of effective dialogue interaction, such as the roles of the interlocutors, the ground rules for commitment and turn-taking, and the type of speech-acts (Searle 1969) that may be performed. The dialogue games that are developed, while sharing the same categories of features (e.g. pre-defined goals, numbers of players, roles, moves and rules, etc.), are distinctive in terms of the actual configurations of these features. They are also different in terms of the particular learning problems they address and the learning processes they support while retaining certain ‘family resemblances’ (Wittgenstein 1953). The approach has been successfully used to design a number of educational dialogue game tools [e.g. DIALAB, Computer-based Laboratory for Language Games in Education (CoLLeGE), CLARISSA, AcademicTalk, and Collaborative Interaction through scaffolding Locutions (InterLoc)] that are reviewed in Ravenscroft (2000) and Ravenscroft and McAlister (2006b). This educationally derived definition and articulation of games is justified in some detail and contrasted with ‘video-game’ approaches (e.g. Prensky 2001; Gee 2003) in Ravenscroft and McAlister (2006a).

The dialogue games are specified in terms of: the goal of the interaction, typically a desired dialogue practice (e.g. expressing a consistent explanatory model, critical discussion and reasoning, exploratory dialogue, creative thinking); the roles of the participants (e.g. discussant, facilitator); the Intentions/Moves that may be performed (e.g. Inform, Question, Challenge); the Locution Openers that actually prompt the expression of the surface-level realizations of the Intentions (e.g. ‘My evidence . . .’, ‘Is it the case that . . .’, ‘I disagree because . . .’); and, the rules of interaction (e.g. about turn-taking and the legitimate sequencing of moves). Another feature, which also influences the degree to which the roles are asymmetrical or symmetrical, is whether or not expert knowledge in the form of a tutor or intelligent knowledge base is used to guide the dialogue. The dialogue game approach is flexible in this respect. It can integrate an intelligent knowledge base or tutor to manage the dialogue along certain strategic lines (e.g. CoLLeGE, described below), or alternatively, foster peer-based collaborative argumentation where the learners contribute the knowledge that is in play (e.g. AcademicTalk and InterLoc, described later).

The sections below describe research that has used this dialogue game approach to investigate, design and evaluate dialogue processes for conceptual change and development. Note that in this article we adopt a deliberately broad definition for ‘conceptual change’, which includes addressing known alternative conceptions in specific contexts, such as physics, and also promoting what is traditionally called cognitive or belief change. Indeed, the work that is reported demonstrates an interesting shift in emphasis in this respect. Earlier work shows how we can use dialogue games to model and structure interactions that reconcile specific alternative conceptions in ways that lead to correct, or target, knowledge and understanding for a particular domain (e.g. the physics of motion). Whereas the more recent research shows how we can use dialogue games to support more generic social and dialogue processes and practices that lead to the sort of reasoned engagement that gives rise to cognitive changes and improved understanding about virtually any subject. So our emphasis has shifted from designing interactions that ‘deliver’ conceptual change for a specific topic to designing interactions that are used persistently to ‘deliver’ improved dialogue and reasoning skills that will inevitably promote cognitive changes. In other words, we have recently prioritized the aim of getting
more learners to adopt practices that involve thinking productively and thinking together in engaging ways that are relevant to them, irrespective of the knowledge that is in play.

A corollary of this shift in emphasis is a related change in methodology and the research questions addressed. Earlier work developed and tested a dialogue game model ‘in the laboratory’ to establish that it did in fact do what it was predicted to do. This was followed by a larger scale experimental field trial that tested the dialogue game approach in a school in parallel with developing and then evaluating another game within quasi-experimental conditions in higher education. The success of these projects has led to the development of a more flexible, generic and powerful approach that has been tested for pedagogical suitability. So the dialogue game approach and the tools that realize it have moved from basic research, which has validated and justified it, to more applied and action research that aims to promote its embedding as a pedagogical practice. This trajectory is described in the following sections.

CoLLeGE: Developing a dialogue game through formal dialogue modeling

Through applying the IBD methodology introduced above we modeled the dyadic processes of collaborative argumentation between a student and tutor that led to conceptual change in science (Hartley 1998). Essentially, this work answered the question: how can an intelligent tutoring partner be designed to manage and facilitate dialogues for conceptual change in science? The relevant dialogical and reasoning features and processes were investigated, represented and formalized through the design of a CoLLeGE that represented a facilitating-dialogue game (hereafter f-dg) that was a form of collaborative argumentation. This modeling tool and its evaluation is described in detail in Ravenscroft (1997) and Ravenscroft and Pilkington (2000). Essentially, it is a dialogue modeling work-bench that allows the formal exploration and investigation of: (i) the alternative conceptions expressed by students, (ii) the repertoires of dialogue tactics or moves that can be performed in response to these alternative conceptions, (iii) the reasoning that is needed to decide the suitable tactics, and (iv) the way in which the tactics are selected and sequenced according to strategic pedagogies (Ravenscroft 2000).

Validating the tool design and evaluating the dialogue game model

Having developed the f-dg model and CoLLeGE tool, we validated them from a computational and educational perspective. This meant checking that the computer system did in fact model the underlying dialogue processes and generated the desired dialogue tactics that a facilitating tutor performed, or wished to perform – which it did. So CoLLeGE provided important and unambiguous insights into the dialogical and pedagogical processes and strategies that stimulated conceptual change. In addition to verifying the computational model and investigating the features of the dialogue process, a small-scale evaluation study tested whether the model stimulated belief revision that led to conceptual change. This involved a (human) tutor performing the facilitator role as specified by the CoLLeGE model. A full account of these computational and empirical studies is given in Ravenscroft (1997, 2000) and Ravenscroft and Pilkington (2000) and they are summarized below.

The chosen subject for the study was kinematics, and used the context of a person pushing a box or trolley along a (horizontal) floor – which was a context taken from previous research into conceptual change in science (Twigger et al. 1991). As we were validating the model and the alternative conceptions that the dialogue game was addressing had been shown to be prevalent in adults as well as students, we decided to use subjects with a range of education and experience. So those selected were deliberately diverse, including two pupils from a local school, three postgraduate students, one undergraduate and five adults engaged in various professions. During the experimental sessions, these 11 learners provided an initial explanation of the box or trolley pushing event prior to playing the dialogue game with a (human) tutor-facilitator performing according to the specified framework. The latter documented the discourse on a flip-chart in an equivalent form to the CoLLeGE interaction language, and all these sessions were transcribed. Later, these records were entered into the CoLLeGE system, so its tactics could be generated and compared against those selected by the tutor. In this way, the system’s ability to simulate the discourse was tested. To examine the learning process, the experimenter checked the dialogues against the CoLLeGE inputs and outputs, noting conceptual difficulties and
any differences, and assessed the explanatory models of the students as being consistent, complete and general in terms of the system’s diagnostic criteria.

All 11 learners showed, in varying degrees, deficient explanations and alternative conceptions in their initial narrative and explanatory accounts. During the subsequent f-dgs eight learners developed explanatory models of the event scenario that were complete and consistent, and which included the equilibrium condition under constant motion, with push and friction agents classified as forces. Five learners were also able to generalize their explanations and specify them in terms of net force. A delayed post-test (4–6 weeks after the initial trial) showed that the learners, with just one exception, held to their revised and improved beliefs, shown in the dialogue game sessions. The dialogue game sessions lasted between 30 min and 1 h, depending on how easily the learner was able to improve their explanatory model.

To summarize, these studies: (i) demonstrated the value of the developed dialogue game and CoLLeGE models in stimulating reasoning and conceptual change, (ii) confirmed the efficacy of IBD methodology that produced these models, and (iii) provided valuable insights into how we could design features and processes for pedagogies to support conceptual change related to the school Physics curriculum. So this dialogue game approach was more thoroughly tested in a larger empirical study. This evaluated the effectiveness of the f-dg through experimental field trials linked to the school Physics curriculum in a school in Milton Keynes in the UK.

Field trials of the f-dg within the school Physics curriculum

To test the effectiveness of f-dg it was compared with two other conditions, an elicit-inform game (hereafter ei-dg) and a ‘no dialogue intervention’ condition that was used as a control. This involved a researcher performing the facilitating tutor role (as specified by the CoLLeGE model) and also the informing-tutor role. The ei-dg supported a collaborative discourse that was similar in certain respects to the f-dg, i.e. a dyadic tutor–student interaction, but the key difference was that it used didactic moves rather than more Socratic style facilitating ones, i.e. when the student responded to a question with an incorrect answer they were simply told the correct answer. This design allowed us to examine whether it was the probing, prompting and challenging features of the f-dg game that made it effective. The study is described in detail in Ravenscroft and Matthe

The evaluation focused on the topic of ‘forces and motion’, as the previous research reported above had shown that a collaborative and argumentative tutoring dialogue, that was analogous to the f-dg, was necessary to support students in developing an improved conceptual understanding of this domain (e.g. Hartley 1998). More specifically, it has been shown that this type of discourse was needed to assist students in overcoming pervasive alternative conceptions, such as ‘a force implies motion’ (Clement 1982; Gunstone & Watts 1986) in order to develop a more complete, consistent and general conceptual understanding of this topic (Hartley & Ravenscroft 1999; Ravenscroft 2000).

Study details and context

Thirty-six students participated in the study that were in Year 11 of the secondary school and were aged between 15 and 16 years. They were all studying Science and had been taught the relevant topic as part of their normal classroom teaching. Twelve students were assigned to one of the three conditions, with the study following the procedure of pre-test, dialogue intervention/no dialogue intervention, post-test and delayed post-test.

Following the pre-test, depending upon the condition, the subjects either participated in the f-dg, or the ei-dg, or, in the case of the control condition, they received some teaching on an unrelated topic.

Results

The results of a quantitative analysis of the pre-, post- and delayed post-tests scores showed that the introduction of the dialogue games produced significant improvements in students’ knowledge of the topic compared with conventional teaching alone ($F_{2,33} = 7.97, P < 0.05$), with these improvements in the students’ explanatory models being retained in the delayed post-tests ($F_{2,33} = 3.32, P < 0.05$). Post hoc analysis showed there was a significant difference between the f-dg and control condition and a significant difference between ei-dg and control condition at post-test and delayed post-test.

© 2007 The Author. Journal compilation © 2007 Blackwell Publishing Ltd
Chi-squared analysis – of responses to the question that was designed to elicit friction – showed that both dialogue games produced significant improvements in stimulating the students to develop a more complete understanding, by introducing friction into their explanatory models ($f-dg$: $\chi^2 = 6.1, \text{d.f.} = 1, P < 0.05$; $ei-dg$: $\chi^2 = 10.3, \text{d.f.} = 1, P < 0.05$), with a slightly larger improvement being noted for the $ei-dg$ condition.

An analysis of responses to questions that elicited known alternative conceptions related to force and motion, showed that there were significant differences between conditions between pre- to post-test ($F_{2,33} = 5.39, P < 0.05$) and pre- to delayed post-test ($F_{2,33} = 3.32, P < 0.05$). Post hoc analysis showed that there was a significant difference between each of the two dialogue game conditions and the control condition between pre- and post-test and a significant difference between the $f-dg$ and the control condition at delayed post-test.

It was interesting that all students had difficulty in generalizing their models by expressing them in terms of ‘net forces’, because they did not understand the concept of ‘net’, and for this reason, the dialogue games were shorter in duration than was anticipated, being conducted for up to 30 min.

**Discussion of the field trials**

These results clearly demonstrated the effectiveness of both dialogue games in stimulating improvements in the students’ understanding of the physics of motion, with the $f-dg$ showing greater improvements. It was also noted that the dialogue games worked differentially in addressing the conceptual difficulties experienced by students. The $f-dg$ was more effective in addressing alternative conceptions about the context, such as ‘force implies motion’, with the improved conceptualizations being retained in the delayed post-tests. Whereas the $ei-dg$ appeared slightly more effective in addressing incompleteness in the student models, such as the exclusion of friction. The difficulties that the students experienced with the concept of ‘net’ and consequently ‘net force’ accords with previous findings reported by Hartley and Ravenscroft (1999).

The outcomes of this research had clear implications for the role of dialogue and argumentation in learning and designing collaborative learning interactions. A striking finding was that the addition of up to 30 min of a stylized collaborative inquiry dialogue about this topic produced significant improvements in students’ knowledge and conceptual understanding compared with ‘conventional’ teaching alone. A more argumentative dialogue, employing challenge, persuade and resolve tactics to reflect back the underlying logic, and the students’ ‘illogic’, appeared necessary to address pervasive alternative conceptions experienced by students. Whereas informing within a collaborative dialogue context is necessary when students cannot introduce the key concepts into their conceptualizations in order to develop a complete and logically consistent model.

So key questions raised by this research were: can we generalize and improve the power of the approach? Specifically, can we remove the reliance on dyadic interaction with a stylized tutor or intelligent knowledge-based system, and instead design generic tools that promote the desirable argumentative processes in more symmetrical peer learning contexts? And, could these tools enable students to practice and improve their critical discussion and reasoning about any relevant topic? Or, could we design tools that promote desirable dialogue practices, articulated as dialogue games for group interaction, that hopefully lead to the adoption and internalization of these social processes in ways that lead to improved dialogue, reasoning and conceptual development?

**AcademicTalk: Promoting argumentative practices for reasoning, collective inquiry and knowledge development**

While the school-based field study was being performed a parallel project was developing a tool, called AcademicTalk (shown in Fig 1), which addressed the questions above. This mediated a dialogue game for critical discussion and reasoning (hereafter $cdr-dg$) between peers. The findings from previous empirical studies (e.g. Pilkington 1999; Ravenscroft 2000; Ravenscroft & Matheson 2002) and computational modeling (e.g. Ravenscroft & Hartley 1999; Ravenscroft & Pilkington 2000) were fed into this project to design this more generic approach that supported the processes and practices of synchronous group-based collaborative argumentation (McAlister 2004; McAlister et al. 2004a; Ravenscroft & McAlister 2006a) and ‘inter-thinking’ (Mercer 2000).

This tool operates within a sequence of educational activities, typically involving ‘preparation interaction-
summary’ exercises linked to the content of a course. It facilitates productive collaborative argumentation among small groups of (4–8) students through examining the arguments and evidence around specific issues on topics that are related to the course content. Its key features are described below.

The use of sentence openers to scaffold critical discussion

AcademicTalk structures and scaffolds the interactions of students during discussion. A key way this is realized is through the use of generic locution, or sentence, openers, such as ‘Can you elaborate? . . .’, ‘Is there evidence? . . .’ and ‘I disagree because . . .’. In this work their primary role was to scaffold a more scholarly approach to dialogue during the students’ discussions. The openers aimed to deepen and extend the students’ interactions, by facilitating questioning and qualifying propositions (e.g. ‘Why do you think that? . . .’) and ‘That is valid if . . .’), introducing evidence (‘My evidence . . .’), and prompting rebuttals (‘A counter-argument is . . .’). Note that this work is different from previous research that has used locution or sentence openers in a number of ways. Previous work has tended to focus more exclusively on the use of the openers (e.g. Flores et al. 1988; Robertson et al. 1998; Lazonder et al. 2003) or used them in the context of problem-solving behaviour (Baker & Lund 1997; De Vries et al. 2002) and it is fair to say that the findings about their value and effectiveness have been mixed, which are nicely summarized by Lazonder et al. (2003) and Soller (2000). However, in this research these openers form part of a broader, and quite sophisticated, interaction design that includes the additional features of dialogue games that are themselves part of a surrounding learning design. In brief, while the openers are the primary form of expression that are used during the interactions in dialogue
games, they are tactical possibilities that are governed by rules of interaction and located within carefully constructed contexts. It is likely that this somewhat holistic approach to the deployment of this scaffolding technique is what contributes to the positive findings that are reported in this article.

Managed synchronous dialogue

The AcademicTalk tool presents messages organized by thread and linked by a reply relationship, so that coherent strands of argument develop on a theme. To support this there are two displays. Figure 1 contains an interchange\(^1\) from a discussion about the origins of Graphical User Interfaces, taken from the evaluation reported below. The first display shows an ‘abbreviated’ hierarchical display of messages within each thread, with the more recent messages being made visible. The second display always shows the selected message within the hierarchy, and is useful for composing a reply which will extend the argument. An advantage of this managed synchronous discourse is that any message in the discussion may be considered and replied to at any time, giving some of the reflective advantages of asynchronous dialogue and overcoming common problems of sequential incoherence that have been reported with Chat (Herring 1999).

Guidance on opener selection

Opener suggestions for reply are highlighted in the interface to prompt sequences, or patterns, of legitimate argumentation. Although these are not enforced, the suggested openers realize maxims for how coherent arguments develop and suggest a ‘local context’ for possible replies in the argument strand. Figure 1 shows AcademicTalk during opener selection while composing a reply, which in this case is a response to an explanatory Inform move. So the participant is prompted to perform either a Question, Challenge or Reason type of move as a legitimate response, with the specific opener – ‘I disagree because . . .’ being prompted from the Challenge category. So, a form of flexible and optional structuring is provided at the opener selection level, which can prompt the student to consider alternative replies, and in turn, more deeply consider the issues under discussion.

Evaluation of AcademicTalk

An evaluation of this tool with open and distance learning students at the UK Open University produced clear and positive results. This is described in detail in McAlister (2004) and McAlister et al. (2004b) and summarized below.

In this study AcademicTalk was compared with Chat for the same learning activity within quasi-experimental conditions. The study involved a series of five discussions of a particular topic for each condition that each involved two \(c_{dr-dg}\) sessions lasting approximately 1 h. These were run with groups of four or five students (i.e. 20 AcademicTalk sessions in total). Half the groups used only Chat (\(n = 19\)) for their discussions, and half used only AcademicTalk (Talk, \(n = 15\)). The purpose of the study was to see if the structured interactions led to a deeper and more extended argumentation process than unstructured interactions. The topics for discussion were chosen to be controversial issues to stimulate argument, and to coincide with the students’ course reading.\(^2\) The 34 students in the sample were from two different cohorts taking a first level development of technology course offered by the UK Open University. Twenty-nine of them were new to higher education, and of these 16 had low formal qualifications.\(^3\) The students were recruited as volunteers from regional student online fora and the study (like the course) was run online without the researchers or the students meeting face to face.

All the students who responded to online questionnaires (i.e. 65% of those taking part) were unanimous that the time spent was worthwhile, and that they enjoyed the discussions and they would do it again. They also agreed that it gave them something they could not get elsewhere on the course and that it helped their understanding of the course.

Tutors selected episodes showing ‘good educational interaction’ to compare argumentation in each condition, which amounted to 18% of the total dialogues. These were analysed to compare: (i) the amount of off-topic and on-topic dialogue, (ii) counts of the types of

---

\(^1\)Note that in order to anonymize the contributions and yet retain the ‘look and feel’ of the interaction and gender – interlocutors are given an alternative name to their actual name.

\(^2\)An example topic was ‘The Windows PC owes its success to features, like the graphical user interface, that were first developed for the Apple Mac’.

\(^3\)Less than two GCSE A levels.
dialogue moves performed, (iii) frequency of requesting and providing evidence, and (iv) use of claims and rebuttals, using the Toulmin Argument Pattern (TAP) schema developed by Osborne et al. (2004). The results showed that the AcademicTalk condition: (i) supported virtually no off-topic discussion, 1% compared with 24% for Chat; (ii) supported greater use of argumentative moves such as Explore, Withdraw and No Commitment compared with the more neutral Inform, Inquire and Reply that were common with Chat; (iii) supported more frequent requesting and referring to evidence, 14% compared with 9% for Chat; and (iv) were rated more highly on every level of argumentation measured by TAP.

These analyses along with a more qualitative assessment of the dialogues (see McAlister 2004) showed that with AcademicTalk students addressed previous contributions more clearly and directly and more arguments were examined and challenged compared with students using a Chat client. Students were able to engage in more thoughtful and relevant contributions using this tool, and felt able to challenge others with direct questioning, which rarely occurred in similar Chat discussions on the same topics and with the same preparations. This was shown in the strength and frequency of rebuttals in discussions, which was not replicated in the Chat discussions. In summary, the findings showed that this dialogue game approach led to a more coherent, deeper and yet more varied process of argumentation than was possible with less structured approaches, such as the use of Chat. An essential difference seemed to be that whereas Chat encouraged the simple ‘trading’ of opinions and more personal interchanges, AcademicTalk stimulated the interlocutors to question and challenge the ideas that were in play, rather than the person who was proposing them.

However, during later projects we noticed that in order for the AcademicTalk approach to be optimally effective there needed to be a greater emphasis on setting up the appropriate conditions for effective argumentation (Ravenscroft & McAlister 2006a). This meant using the tool within a more flexible ‘learning activity model’ that went beyond simply assuming a pre-set ‘preparation – interaction – summary’ sequence and also carefully linking the topics of the discussions to the interests of the students as well as the requirements for the curriculum. Also, it was clear that the cdr-dg supported by AcademicTalk was just one example of a potential family of dialogue games for reasoned dialogue, suggesting that other dialogue games for creative thinking (Wegerif 2005), exploratory dialogue (Wegerif & Mercer 2000) and such like should also be realized through an AcademicTalk type tool. In brief, we realized the potential of a more powerful and flexible dialogue game tool that supported a range of games and integrated these with the pedagogical and technological activities relevant to users.

**InterLoc: Scaffolding relevant, engaging and inclusive learning dialogue**

The success of the CoLLeGE and AcademicTalk projects and the clear benefits these approaches provided in stimulating reasoning and supporting the argumentative processes and practices that promote conceptual and cognitive change has led to a considerable expansion of this line of work. In recent years, through three consecutive projects, we have developed a more flexible and powerful dialogue game tool called InterLoc (see http://www.interloc.org/). This tool: (i) integrates various media formats to support multimedia dialogue games, (ii) provides a well-coordinated and engaging learner experience (through additional dialogue modeling and improved interface design), (iii) locates and links the dialogue game exercises to related pedagogical practices, (iv) provides a number of different and adaptable dialogue games (i.e. critical discussion and reasoning, exploratory dialogue and creative thinking), and (v) is built according to open standards for interoperability and reusability). The current InterLoc tool is shown in Fig 2 and described in detail in Ravenscroft and McAlister (2006b) and Ravenscroft et al. (2006a).

In addition to scaffolding dialogue and reasoning skills, this tool, more generally, supports the sort of enjoyable risk-free engagement that leads to a greater confidence in participating in the academic forum of critical debate. Essentially, the interaction that is implemented through InterLoc more fully exploits a gaming metaphor (Ravenscroft & McAlister 2006a) to allow students to play with, practice and develop their academic, dialogue and cognitive skills in an engaging and motivating way.

---

4The current InterLoc tool is available from the SourceForge repository for Open Source applications (http://sourceforge.net/).
The key interface that currently mediates the dialogue game process is shown in Fig 2. This interface includes: (i) a Select Activity window which organizes and locates the user within related learning activities (e.g. readings, asynchronous question setting, synchronous game interactions, summaries, etc.); (ii) a Browse Messages Window that provides a number of options for viewing the total dialogue during an exercise (e.g. by topic, time or player); and (iii) a Conversation Display which is the focus during the dialogue games. This intuitive design supports slick coordination between the argumentative subdialogues a participant is actively engaged in and the total message list that conveys the whole dialogue, and also fosters focus and coherence during the games. Collectively, these features produce high levels of engagement in the dialogue game process with little attention needing to be paid to understanding how the interface works.

The brief excerpt in this interface was taken from a trial with postgraduate student teachers of Mathematics at the University of Southampton, which was part of a larger pilot study (see Ravenscroft et al. 2006a), illustrates students engaged in coherent critical discussion using the InterLoc CDR game. This excerpt demonstrates disagreement leading to an elaboration request that prompts justification through referring to evidence. Jacob5 starts this interchange using the Opener ‘I agree because . . .’ to express his agreement to the predefined discussion question, about how students should receive

5As with the Fig 2, note that in order to anonymize the contributions and yet retain the ‘look and feel’ of the interaction and gender – interlocutors are given an alternative name to their actual name.
feedback from teachers. This prompts Alex to disagree with Jacob’s Assertion using ‘I disagree because . . .’ to argue for better methods of feedback, rather than just presenting a mark. This stimulates Alex to prompt Jacob for some elaboration of his position using ‘Can you say more on that . . .’, which prompts Alex to explain that he read some evidence to qualify and elaborate his position, which says that although commenting is beneficial there is no evidence that grading is harmful. This in turn prompts another participant, called Amy, to request the nature of his elaboration using ‘Where did you read that . . .’. Even this brief excerpt demonstrates how using InterLoc leads to a reasoned, coherent and yet varied dialogue, with players using a range of moves to create constructive conflict within a legitimate argument.

Discussion: key insights and ongoing work

A reflective analysis of this line of work gives rise to a number of key insights about the role of dialogue and related innovations in the learning process. First, although investigating educational dialogue is a complex and time-consuming process, the application of formal analysis and modeling techniques can identify the features and patterns of moves that can be designed into interaction scenarios that can support learning in a range of contexts. And further, some significant learning objectives may be difficult or impossible to achieve in other, more conventional and less dialogue focused ways. In the school-based field study reported, although all students had been conventionally taught the ‘correct’ physics, virtually all these students retained significant alternative conceptions that were only reconciled through the intervention of the dialogue games. Second, a focused collaborative dialogue about a topic can give rise to significant improvements in learners’ understanding without the involvement of an expert tutor. The success of the f-dg and ei-dg in stimulating conceptual change, where the experimenter was an educational researcher with no specialist physics knowledge, demonstrates that these improvements were due to the quality of the dialogue that was performed and not the expert knowledge of the participant playing the facilitating or informing role. It seems that these dialogues fostered the sort of ‘intersubjective orientations’ (Wegerif 2005) where learning could happen, where it was probably the quality of the local relationship between the participants that developed through the dialogue game that assisted the learning process. Third, generic dialogue tools, such as Chat, and presumably by implication discussion forums and such like are unlikely to mediate successful educational dialogues when their design is devoid of a learning model and pedagogy. Supporting ‘Chat’ and ‘Synchronous discussion’ should not be confused with mediating high quality and engaging critical dialogue and discussion that supports conceptual and cognitive change. To realize the latter we have to design for it and not expect it to simply emerge from an unstructured interaction. Finally, a key recent finding is that effective learning dialogues need to take account of emotional, social and cognitive dimensions. Students may need to overcome emotional barriers in order to meaningfully participate in critical dialogues before they benefit from the structuring and scaffolding that links social and cognitive dimensions, which accords with Ravenscroft’s (2004) argument for a socio-cultural framework for cognitive change. A corollary of this is that the dialogue game designs, and the ground rules they embody are successful in legitimizing the sort of critical behaviour that breaks usual social norms. Having explicit moves for challenging, questioning and requesting justifications, etc. linked to rules prompting legitimate patterns of moves, seems to legitimize critical behaviours that are educationally valuable but socially impolite.

Pervasive dialogue games

The success of a pilot study of InterLoc has led to a large-scale project, running for over 2 years, which is adapting and implementing the dialogue game approach initially within five UK Higher Education Institutions and then disseminating the approach at a national and international level. Additional ongoing theoretical work into the anatomy of learning dialogue performed by Ravenscroft et al. (2006b) based on the contrast between ‘dialectic’ and ‘dialogic’ dialogue, as it has been articulated in socio-cultural psychology by Vygotsky (1986) and Bakhtin (1986), respectively, and recently by Wegerif (2006), is also being fed into these developments. The vision for this work is to make the digital dialogue games an ambient and yet integrated technology that supports inclusive and personalized learning. These requirements will be realized in a

---

6As Amy is making her response, she is not yet recorded in the Conversation Display. This interface was reconstructed through loading the actual transcript.
number of ways. First, learning activities will be made as relevant and motivating as possible, drawing on the preferences of participants and the digital artefacts that are meaningful to them, rather than being perceived as ‘external’ activities that are ‘imposed’. Second, we will address the requirement for appropriate emotional engagement and empowerment, as without addressing the emotional dimensions of the social practices that lead to the acquisition of dialogue or conceptual skills, these practices are likely to be hindered or even prohibited. This argues for the role of ‘serious play’ in education, where semiformal learning activities foster risk-free yet meaningful engagement that leads to the development of social and conceptual skills. Third, we will more tightly couple the design features of InterLoc with the digital behaviours of its users and potential users, through linking with mobile and wireless devices (e.g. PDAs, mobile phones and Ipods) that support formal or informal learning activities. In brief, we are making InterLoc and the digital dialogue games an ‘anyone, anytime and anywhere’ technology.

Role of argumentation in contemporary science learning

An interesting parallel movement in science education neatly converges with the current status of the work reported in this article. The curriculum for 21st Century Science Project places a considerable emphasis on developing students’ abilities to systematically criticize, contrast and reconcile different scientific theories rather than simply teaching both. Yet, teachers have reported considerable difficulties in teaching these evaluative and critical skills. The dialogue game approach proposed in this article, with its emphasis on scaffolding argumentative dialogue practices, should provide an appropriate method to address this problem. Also the multimedia capabilities of the InterLoc tool means that these dialogues can be linked with interactive content, such as simulations, models and such like, which are the topics of scientific inquiry.

Conclusions

Arguably the strongest message that emerges from this line of work into dialogue games is that digital learning technologies can mediate, catalyse and amplify fundamental human communicative processes in the pursuit of deep learning. Dialogue is arguably the primary medium by which we understand and change the way we understand the world, express and convey our own identities and also form the sort of relationships that create the spaces where learning can happen. So new and emerging technologies need to work with our natural communicative propensities and build on existing semiotic systems, such as our natural languages. Conversely, it is essential that we do not ‘replace’ dialogue-rich learning practices with ones that are communicatively impoverished, such as an over-reliance on ‘interactive content’. In brief, in our digital age it is more important than ever, regardless of the complexities involved, that we work with dialogue and not against it.

Acknowledgements

The author is very grateful to the many colleagues who have significantly contributed to this line of work. They include Professor Roger Hartley, Dr Conroy Mallen, Dr Rachael Pilkington, Professor Eileen Scanlon, Dr Mark Matheson, Dr Simon McAlister and all members of the AcademicTalk and InterLoc project teams at London Metropolitan University, University of Southampton, UK Open University, Exeter University, Oxford University and Bolton University, see http://www.interloc.org/. The excerpt shown in Fig 2 is taken from a trial organized and ran by Professor Rupert Wegerif and Dr Annamaria Carusi at the University of Southampton. Recent work on the AcademicTalk and InterLoc tools has been carried out with the support of the UK Joint Information Systems Committee (JISC) in the framework of the ‘e-tools for teachers and learners’ programme. The content of this paper does not necessarily reflect the position of the JISC, nor does it involve any responsibility on the part of the JISC. The author is also especially grateful to the staff and students at the Lord Grey School in Bletchley, Milton Keynes, UK – who generously offered their time and interest in the field study project that is reported.

References

Bakhtin M. (1986) *Speech Genres and Other Late Essays*. University of Texas, Austin, TX.


Ravenscroft A. & McAlister S. (2006b) Designing interaction as a dialogue game: linking social and conceptual


