"Open" Computer Software Design

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Introduction

For a long time, instructional developers have pursued the dream of creating computer-assisted instruction (CAI) of such quality that the interaction between the computer and the user would be indistinguishable from that between a learner and an experienced, capable, informed, patient, and sympathetic teacher. Each new wave of computer technology, bringing with it more power, more memory, more whatever, has augured the arrival of the dream. And each wave has brought with it claims that computer-assisted instruction in tutorial mode is now, at last, effective, efficient and fun. Perhaps others don't feel the same way, but I feel that the dream is a very long way from being realized. Indeed, I wonder if it ever can. For me, programming the current generation of computers to dialogue directly with humans, even to the limited degree of expecting the machines to ask sensible questions and judge specific answers in context, produces human-computer dialogue that is, more often than not, stilted, either obtuse or simplistic, limited in scope and in vocabulary, straight-jacketed and often just plain boring. I would go further: it is the wrong thing to be trying to do.

I no longer accept the notion that it is possible to "engineer" a solution to a learning problem and to pass across to a computer the responsibility to effect the solution. I no longer trust the educational engineer to construct a machine (by programming a computer) that can deliver instruction as one might deliver a candy bar or a packet of cigarettes.. Make no mistake. I believe technology is important and useful if kept in its place - as a stimulus to dialogue between humans. But for me it is what happens off thescreen that really counts as educational experience. For me, the quality of software has to be judged by the quality of debate it helps generate among students and between the students and their teacher, not by its ability to make students conform to a prepackaged notion of one side of a preordained human-computer interaction.

A new type of educational software has begun to emerge. Instead of keeping students busy but quiet, while the teacher gets on with other things (Eraut and Hoyles, 1988), the new wave software that we are talking about keeps students so volubly active that teachers cannot escape being drawn into the experience, however hard they might try not to get caught up in the search for understanding through dialogue. As I put it in another paper, the new wave of software is such that there is generated around the machine a "zone of proximal development" (Vygotsky, 1962) shared by the students, the teacher and the subjective machine (McMahon, O'Neill & Cunningham, 1992). We are pointing to the emergence of a strain of educational software sympathetic to a constructivist view of learning, to software which offers an alternative to the embodiment of behavioral and information processing theories in prepackaged instruction. Central to the constructivist view is the acceptance that, above all, learning is a social process taking place in a context in interaction though dialogue with others. In the

constructivist view, instruction is less a process of communicating knowledge to learners and more a matter of nurturing the processes whereby learners come to understand, share and construct multiple perspectives and interpretations, develop and learn to defend their own positions while recognising those of others and become self aware in the sense that they can recapture their situated experience and exploit their understanding of the knowledge construction process itself (Cunningham, 1991).

Put another way, we would like to distinguish between "open " and "closed" software. Open software is distinguished from closed software in that the latter typically provides the objectives to be mastered, the context, content, and means of assessment all as part of the software package. Most of the software found in today's classroom falls into this category and, indeed, much of the software that has appeared recently under the influence of constructivism (e.g., Spiro, Feltovich, Jacobson & Coulson, 1991; Cognition & Technology Group, 1991) may be characterized as closed in this sense. Open software, on the other hand, is largely empty of content, but designed to be flexible enough to fit within the context and learning goals of the user, open to simple and timely customization. Perhaps the best example of open software is HyperCard, which allows nearly infinite customization by the user within the limits of the card format. But HyperCard itself is perhaps too open. It requires a considerable amount of time, effort, and commitment to master the intricacies of buttons, fields, etc., and especially scripting. What we have in mind is open software that is relatively easy to master and maximally adaptive. In this paper I will describe the development and evaluation of a software tool of this type: Bubble Dialogue. I believe that its use by imaginative teachers can produce conditions in the classroom where students are motivated to engage for surprisingly long periods in the constructivist processes outlined above and elsewhere (e.g., McMahon & O'Neill, 1991; Knuth & Cunningham, 1991). Through a combination of elements of role play, comic strip creation and a process called reflexive dialogue analysis, students engage actively with their own ideas and those of others, including those of their teacher. Through first the creation of bubble dialogue in context and then reflection about that dialogue, they have the opportunity to express personal (perhaps naive) views of the world, to contemplate multiple perspectives in both public and private domains and to accommodate their own thinking to contrary views. By sensitive selection of the roles and the topics of bubble dialogue, the teacher can ensure that learning takes place embedded in realistic contexts relevant to everyday life (Brown, Collins & Duguid, 1990).

Bubble Dialogue

The power of the comic strip to hold the attention of the reader is well known. Three key elements are juxtaposed in comic strips: graphics which stylize the characters in the story, narrative text (usually in a banner at the top or bottom of a panel) that economically conveys the story line or acts as a commentary on the action and its effects on the characters, and, most importantly, dialogue that, by a well established graphical convention, can be readily identified as either character's

individual speech or thought. To be honest, we were not aware of the theoretical implications of each of these features when we began the project to create Bubble Dialogue. In fact, our initial purpose was to allow children to construct their own comic strips, using characters and stories of their own choosing. But over a period of approximately two years of research and development it became apparent that we had created a tool which could provide insights into a number of theoretical concepts compatible with constructivism (e. g., Cunningham, 1991): multiple perspectives, reflexivity, dialogue as a means of constructing knowledge, multiple modes of representation, public versus private speech and so forth (see Knuth and Cunningham, 1991 for an elaboration of these theoretical concepts in the context of software development). In this regard, we have used the tool in a number of modes: as an ethnographic research tool (O'Neill and McMahon, 1990), as a tool for instruction in schools and teacher education (McMahon, O'Neill and Cunningham, 1991) and as a tool for the development of literacy (O'Neill, McMahon and Cunningham, 1991). Recently we have opened up discussions with leaders in the training sector in Northern Ireland, the U. S., and elsewhere on its potential application in a range of training settings.

Some features of the Bubble Dialogue tool

Our early explorations of Bubble Dialogue led us to the conclusion that it was a tool with great potential in a variety of applications. Classroom teachers with whom we shared the early prototypes saw many uses over and above our initial conception. Some saw it as a means to stimulate creative writing. Others believed it could be used to help the children explore their feelings about particular issues and problems that they confronted in the classroom. But all of our colleagues were taken by the use of dialogue as a means to promote understanding of issues and situations of relevance to the children's school experience. We saw immediately that the power of the tool and its attraction to users would lie in its versatility - in principle, it should be possible to create bubble dialogue between any characters in any context. In practice, users had to be able readily to create or choose characters, paste them into the comic strip framework and launch them into situated dialogue. In anticipation of this stage of our

work we have made design decisions intended to make it as easy as possible for students and others to explore issues and ideas in contexts chosen either by themselves or by their teacher. In other words, our design was to be "open" as much as possible, while accommodating to the range of computing skills we were likely to find in our intended population of users We have responded to this requirement by creating a stack called BubbleMaker, a master stack which is used to make customised bubble dialogue stacks for later use. Figure 1 shows the graphic interface, we call it the workspace, used to create a bubble dialogue stack.

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Insert Figure 1 about here
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In the workspace, a suitable graphic is chosen from a library (included in

the software) or imported from an external source, the characters are named and the setting is described in a prologue, such as the one in Figure 1. The purpose of the prologue is to point to an issue and to indicate the beginning position of the characters on the screen without at the same time overly constraining the users as they create their dialogue. The context can then be fine tuned by allocating an opener, a first speech and/or thought, to one of the characters (Mary's speech bubble in Figure 2 is the opener in this particular dialogue). With these steps completed any number of copies of the customised stack can be created for students to "fill" with dialogue.

Each page of a bubble dialogue stack contains four icons, representing a speech bubble and a think bubble per character. Clicking on one of these icons brings up an empty speech or think bubble for the chosen character. We have found that both children and adults readily engage with the characters, debating what they should be made to say and think and often competing with one another to enter text into the empty bubbles. Typically, as the dialogue is created, users show every sign of being thrown forward by the emerging dialogue in much the same way as one finds oneself thrown forward in animated discussion.

One of the important features we have incorporated in the tool is the distinction between creation and review modes. In creation mode (see Figure 2), the only movement possible is forward - to the next chosen empty speech or think bubble. In addition, during creation of dialogue a turn-taking protocol makes sure that users cannot make either character have an extended conversation with himself or herself. Once a character has had one speech, and optionally one thought, the user's only course of action is to transfer attention to what the other character is going to be made to say or think.

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Insert Figure 2 about here
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In contrast, in review mode, which can be switched into at any stage, the user can move backwards and forwards through the comic strip at will, adding notes, editing the text of the dialogue, adding thoughts or speech where they did not previously exist, or extending the dialogue beyond its "ending."

We have found the use of the tool in review mode to be very powerful, encouraging reflexivity in the users. By reflexivity, we mean the ability of students to be aware of their own role in the knowledge construction process (Cunningham, in press). In some cases , reflexivity is shown by the students' ability to verbalize the process of projecting positions on to the characters. Awareness of the distinction between public (speech bubbles) and private (thought bubbles) speech is also fundamental. In addition, we have included a number of design features in the review mode to foster reflexivity. For example, sometimes we allow students to review their own dialogues and add comments in a "notes" field (accessed by clicking an icon) about "what's happening" or comments on the motives and feelings of the characters (See Figure 3. Example 1 in the Appendix shows

an extended example of the use of the notes field). At other times we have asked students to add thoughts to a dialogue previously created by their

peers using speech bubbles only. Teachers and researchers may also annotate the dialogues in any manner they see fit: as field notes, commentary on the dialogue from the teacher's point of view, questions for the students to consider as they review their work, etc.

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Insert Figure 3 about here
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At any time, getting access by a reserved key stroke, the teacher can set or reset a number of options: unlock or lock existing text so that it can or cannot be edited, allow or disallow the choice of new think or say bubbles, change the names of the characters, allow or disallow lookbacks, change text size. This facility allows the teacher to present the tool in a wide variety of modes. For example, text created by one group of students can be reviewed by other groups without the danger of the original text being altered. Or students can be invited to add the presumed thoughts of the characters to a dialogue which has already been entered, in speech only, by the teacher.

Finally, we think it is very important that users have access to printout of the dialogue. Clicking on the printer icon produces a comic strip version of the dialogue which the users can carry away with them. The icon just above this produces an annotated script like those found in the Appendix to this paper. These scripts have served a variety of purposes in our work. The creators of the dialogue can engage in further analysis of their own dialogues or compare them with those created by others. These analyses and comparison often serve as the focus of further discussion within the classroom. Likewise, the teacher or researcher can carry the scripts away to contexts like their office or conference room for further analysis. For instance, we have often used these scripts to evaluate new directions for the analysis of "turn-taking" in the dialogue construction process.

A final feature of the Bubble Dialogue tool is an archive which is created continuously. This can be the repository of such information as the users' editing of the content of speech and thought bubbles created by themselves or others, or the sequence in which they add notes during the review process. This too is a promising source of insights into the dialogue construction process, but we have not as yet had the opportunity to formally utilize it ourselves. We expect, however, that communication scholars will find the archive a rich source of data.

Some applications of bubble dialogue

To date we have gathered experience of using the Bubble dialogue tool in a number of contexts; specifically, in research and teaching in the classrooms of primary and secondary schools, and in pre-service and in-service teacher education. In each of these cases, we have found ourselves in a uniquely collaborative environment where the the participants have contributed much to the design and use of bubble dialogue. Open software

tends to have this characteristic

Research in the classroom

Figures 1, 2 and 3 are taken from one of many bubble dialogue stacks used during our evaluation of bubble dialogue as an ethnographic research tool. We have worked in association with colleagues investigating groupwork with computers (Eraut and Hoyles, 1988). The scene, prologue and opener in this stack were created on the basis of the researchers' advice as to their concerns and the concerns of their subjects, primary school children. The stack, and the dialogue which emerged (see Example 1 in the Appendix), is typical of the data collected using the Bubble Dialogue tool within this project. We have taken an initial look at the issues involved in using bubble dialogue as an ethnographic research tool in two other papers (McMahon and O'Neill, 1990; O'Neill and McMahon, 1990) and the work will be the subject of a full report to the funding agency,ESRC/InTER, now in preparation.

Leaving aside for the moment what the tool might have shown us about the children's experience of groupwork with computers, working in this context has shown us that children 8 years of age and even younger have no difficulty in coping with the inherent perspective switching involved in

moving from creation mode to review mode. Further than this, when we began this project, some doubted that the children would be able to cope with the distinction between public and private speech. Not only have the children we have studied to date exhibited this distinction, most have also mastered the extremely sophisticated notion that one character does not have access to the thoughts of the other character, only the public speech. In Example 1, for instance, the competitiveness of the characters Peter and Mary surfaces only occasionally in the public speech but is quite apparent in the thoughts of the characters and in the note commentaries. These 10 year olds appear very aware of the social dynamics of the classroom and of the naturalness of thinking one thing but adjusting public speech to the conventions of the social situation. This awareness of the possibility of multiple perspectives, including the "outside" view afforded during review, and of the difference between a publicly stated view and a private opinion are fundamental to the development of communicative competence. Using bubble dialogue as a research tool exploits the fact that subjects can be persuaded to draw upon this competence as they make characters, not unlike themselves and their peers, reveal their public views and private opinions about matters of concern.

Another example, not included here, had four 10 year olds describing a computer task to a new student. Interestingly, the group chose to describe to the new student the Bubble Dialogue task that they themselves were engaging in for the very first time, in essence, a self chosen think-aloud protocol. Their ability to engage in a task all the while explaining it to an "outside" perspective is almost a prototype case of reflexivity, and rather unexpected if one grants the egocentricity that children of this age are supposed to exhibit.

Thus, we have come to see that the Bubble Dialogue tool has potential

in ethnographic research. Subjects can be placed in a role play situation, allowed to drive their own characters or follow the researcher's characters through a bubble dialogue and then, using the tool in review mode, be asked to record their own reflections as they recapture the meaning of that dialogue. Rather than replacing traditional approaches to data collection, this technique, used alongside others, offers the researcher a potentially rich source of data about users' responses to the issues raised in the dialogue. It provides a facility for the researcher to take a sideways look from a new direction at the way subjects see the world, another avenue for researchers to use as they seek to satisfy the call made by Hammersley and Atkinson (1983) for triangulation in ethnographic research.

Education for Mutual Understanding

We are gradually building up experience of using bubble dialogue in the classroom as a tool for learning and our experience has included an exploration of its use in the context of two of the six cross-curricular themes featuring in the new Northern Ireland national curriculum, namely Education for Mutual Understanding and Cultural Heritage. These themes, which are permeated across all subjects, are designed to engender self-respect, and respect for others, and the improvement of relationships between people of differing cultural or ethnic traditions.

One of the most striking examples of this application of bubble dialogue came in the early days of the development of the tool. An invitation to help out in a history project on the Siege of Derry, being undertaken by a class of thirteen year olds in a Londonderry school, was taken up and the notion of creating bubble dialogue was introduced to a group of five girls. A visit to the 17th century city walls with a video camera, with the children acting both as role players and camera crew, allowed several scenes (defending and attacking soldiers, starving citizens, modern day meetings between locals and tourists) to be captured on video for transfer into the Bubble Dialogue tool.

More by design than by accident, the scenes were captured on a section of the city walls where the work of a contemporary sculptor was installed. A Janus-like statue depicts two life size figures fused together, arms outstretched as in a crucifix, back to back, one looking out over the Catholic Bogside, the other into the walled city. At the right moment Harry speculated aloud, "I wonder what the statues would say if they could speak.", only to be answered by a thirteen year old's joke: "My arms are killing me!". But the children liked the idea of making the statues speak and think for themselves and on the following day, after considerable discussion, they decided that the statues were old, that one was a Williamite and the other a Jacobite, and that they were looking back to their past. The bubble dialogue script presented in Example 2 in the Appendix emerged over a period of about twenty minutes, each sentence being committed to the screen after considerable discussion among the five. It was a matter of great concern as to which statue, soon dubbed the "Protestant" and the "Catholic" rather than the academically respectable Williamite or Jacobite, should next be made to say or to think what, and

why. The outcome was, to put it mildly, startling - to both the typist/observer (Harry) and the children's teacher.

The emerging text seemed to us and to the teacher to have captured the stark reality of the pub and soap-box rhetoric of the Ulster conflict so pervasive in Northern Ireland. The teacher's first reaction was momentarily to feel ashamed that something so starkly reflective of simple sectarian thinking, albeit of both views of the conflict, could have emerged in her classroom. Her next was to wonder how parents would react if they knew that their offspring could produce such writing. Then she asserted that this kind of writing could never have emerged in her classroom by any other method. And finally she claimed that she had a chance now to debate an issue on the basis of the children's own "controversial" writing rather than on material of her own making, artificially introduced. Her immediate request to us was to turn the statues to face one another. Her hypothesis - the new face-to-face dialogue would be interestingly different , and through class debate about the differences, her goal of cross community empathy and reconciliation could thereby be advanced.

One of the striking features of the dialogue script was the reference to the toilets and the swimming pool in the opening speech. When the children decided that this is what the statues should say, Harry, acting as typist and totally perplexed as to why such a thing should be said, had accepted his typing instructions as if toilets and swimming pools were perfectly normal topics for talking statues. Only afterwards, in a conversation with the teacher, did he get an explanation of what had been going on during the creation of the dialogue. Despite the fact that the children had set out to make the statues talk about the past, within moments of starting the dialogue the statues were being made to refer to the children's personal experience of the previous week when they had visited a Protestant school which had a swimming pool and toilets "twice as big" as those in their own school. In a very real sense the statues were being made to talk and think the way the children wanted to talk and think themselves. The statues had helped make it clear that a cross-community school visit designed to bring about "improvement of relationships between people of differing cultural or ethnic traditions" had in fact served to reinforce feelings of deprivation and discrimination.

This experience of children exploring cross-community relations in Northern Ireland, and others accumulated since, have convinced us of the need to look in depth at the use of the technique in curriculum contexts where reflection on the dialogue of conflict and conflict resolution might allow one to come to terms with multiple perspectives on contemporary issues and multiple interpretations of history.

Conclusion

When we designed Bubble Dialogue, we had the feeling that the technique was going to prove to be useful in a variety of ways. Our experience in our own professional field over the last two years confirms our early opinion. And it has been our experience that nearly every time we demonstrate the tool to a wide variety of audiences, more and more potential uses are generated. We now see that the power of this tool lies in its open character, its adaptability to a many settings and contexts. But we want

to be clear. Open software will not replace closed software: there are many occasions where well designed lessons aimed at the attainment of particular learning objectives are necessary and desirable. But we also strongly feel that teachers, researchers, counselors, trainers and so forth, need tools that they can easily adapt to their own uses, that will, in effect, allow them to become their own instructional designers. In

other words, we are advocating the design of tools that will support "Small Time Design" (as opposed to "Big Time Design" accomplished by experts far removed from the user's context), software that permits the design of instruction where and when the need for it arises.

Appendix
Example 1
Two boys and two girls, all aged 10 years, produced this script during training in the use of the tool. The children chose to allocate a boy and a girl to play each character. All four had experience of working with TRAY, a software package involving the identification of words from contextual clues. It was their first time to use bubble dialogue in review mode (notes are indicated by italics in this and all the scripts). In the debriefing session afterwards they thought that they had been "trying to find out what children think about; what's different from what they say". They also said that they would like to try again and "be a bit more serious".

Mary Peter

[Mary and Peter are taking turns at the keyboard working on TRAY. Mary knows a word but it's Peter's turn.]

Mary thinks: Shall I tell him the word?

Mary says: I know a good word that might fit.

Peter thinks: I don't want help from her. I didn't want to work with her anyway.

Peter has a strong dislike to Mary,so he doesn't want her to give him the word.
Peter says: Wait a minute, I've almost got it.It's on the tip of my tongue.

Mary thinks: I bet he doesn't know it .

Mary says: O.K then what is it?.

Mary gets cocky.
Peter thinks: Oh no! What am I going to tell her? I'm really in the soup now!

Peter says: I'm not telling.You just want to know so that you can say you knew it from the start.

Mary thinks: I 'm sure!

Mary says: O'yeah I'm sure .I bet you don't really know.

Peter thinks: Oh blow.

Peter says: How much do you want to put on that then Ms World?

Peter starts to call Mary names.
Mary thinks: I got to find a way to see if he really does know.

Mary says: I'm telling .

Peter says: Little goodie twoshoes! Teachers pet!

Mary says: You're a teachers pet too.

Mary get's her own back.
Peter thinks: I'd better get on with it or teacher will be on my back all afternoon,saying"Are you finished yet,Peter"

Peter says: Look,are we going to do this Tray program or not?That's what

we're here for isn't it.You girls are always arguing!

Mary says: Looks who's talking.Any way the word is teeth.

Mary tells him the word.
Peter thinks: I'd better say something or I'll be out of money completely,I'm broke as it is,let alone with her taking it all away.

Peter says: I knew that all the time,it's just that you were arguing so much that I forgot what I was going to say,that's all.

Peter lies through his teeth to hide his embarassment.

Mary thinks: Little liar!

But Mary knows the truth!

Example 2

This dialogue script was produced by five 13 year old girls in a school in the City of Derry's Bogside, a community perceived by some as representing the Catholic/Nationalist side of the "Troubles" in Northern Ireland. The school is overshadowed by the 17th century walls of the city of Londonderry, which can be seen as standing for Protestant/Loyalist ascendancy. On the walls stand two statues, fused together, back to back, with arms outstretched as in a crucifix. As part of their project on the 1689 siege of the Loyalist city by the Catholic forces of King James II, the children decided to make the statues look back to their past.

[Two statues stand back to back on Derry's walls; all of a sudden, one of them speaks.]

Jacobite says: When I was a young boy life was hard. We hadn't got half as much as you had and we still don't. You've got a swimming pool and we've got nothing. Your toilets are twice the size of ours.

Jacobite thinks: It's not fair. You and your stupid swimming pool. You're no better than us.

Williamite says: Our ancesters fought hard for what we've got.We shouldn't have to suffer for what happened years ago.

Williamite thinks: The Protestents are the better race. History can prove that.

Jacobite says: We are the rightful religion because Catholic was the original religion in Ireland. The Protestant religion is only a recent thing.

Williamite says: The only reason there had to be a new religion was because the old one was wrong.

Jacobite thinks: The original religion wasn't good enough for you and your private swimming pool.

Jacobite says: It wasn't wrong; it just didn't suit you and your fancy ways.

Williamite says: Let's not go over this all over again. Anyway, my arms are killing me.

Jacobite thinks: My arms are killing me too, but I'm not going to let a Protestant get the better of me.

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Figure 1. The BubbleMaker workspace

Figure 2. The tool in creation mode

Figure 3. The tool in review mode

This paper is drawn in large part from McMahon, O'Neill & Cunningham (1992)
Harris (1988) gives a detailed theoretical analysis of the genesis in classrooms of the kind of discussion we mean.
Note that open software can be used to produce closed software as in the tutorials that come bundled with HyperCard.
The BubbleMaker program and supporting materials are available (at a small fee to recover costs of supplies and postage) from Harry McMahon, Language Development & Hypermedia Research Group, Faculty of Education, University of Ulster at Coleraine, Coleraine, Northern Ireland, BT52 1SA.
See Winograd and Flores (1986) for a discussion of Heidegger's concept of "thrownness" and its significance for the design of the human-computer interface.