

Mentoring, Metacognition and Music: An analysis of the interactions used to support creative reflection

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Abstract

This report presents an empirical study of the interactions between human-mentor and learners using a Computer-Based Learning Environment (CBLE) for music called Coleridge. Coleridge is designed to provide the fast playback of musical ideas, thus freeing up time for dialogue and metacognition. A framework is then described for analysing the attempts by the teacher in interactions to stimulate creative reflection in the learners. The analysis framework approaches dialogue analysis from the perspective of goal hierarchies and communicative acts. Results of the analysis suggest that (i) because learners seem unable to make accurate predictions about how a phrase will sound, there is a real learning need for a computer-based mentoring agent for Coleridge, (ii) mentoring and Coleridge promote monitoring and creativity, (iii) when asked a question learners use the strategy of 'evaluate' the phrase and then 'diagnose' what is wrong with it, and (iv) 'critical probing' lead to one learner making an accurate prediction about creative ideas. The report concludes with a brief discussion of how the results of the analysis are being used to inform the design of mentoring agent in the CBLE.

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Contents

1. Introduction.....	1
1.1 Motivating examples of creative reflection.....	1
1.2 Related literature.....	2
2. Theoretical approach.....	3
3. Empirical study based around a CBLE: Coleridge.....	6
3.1 Coleridge.....	6
3.2 Research Method.....	7
3.2.1 Data transcription.....	8
3.3 The study.....	9
3.4 The corpus collected.....	10
4. Analysis approach.....	10
4.1 Pedagogical goals.....	10
4.1.1 Metacognitive goal.....	10
4.1.2 Mentoring goal.....	10
4.1.3 Task goals.....	10
4.2 Interactive Goals.....	10
4.2.1 Critical thinking sub-goal probing.....	10
4.2.2 Creative thinking sub-goals.....	11
4.2.3 Metacognitive sub-goals.....	11
4.3 Communicative Acts.....	11
4.4 Allocation of an utterance to categories.....	11
4.5 Example of dialogue analysis.....	11
5. Results of analysis.....	13
6. Discussion.....	13
7. Conclusions.....	16
References.....	18
Acknowledgements.....	19
Appendix 1: Full description of the study.....	21
1. Introduction.....	21
2. Instructions given to the teacher.....	21
3. Information sheet for students.....	21
4. Task Design.....	23
5. Observer guidelines and questions for interview.....	23
5.1 Observer guidelines.....	23
5.2 Rationale for the questions to learner & teacher.....	23
5.3 Questions for interview.....	23
6. Post-experimental cue data gathering.....	23
7. Data gathered.....	24
8. Reliability of the data gathered.....	24
Appendix 2: Analysis approach.....	26
1. Pedagogical goals.....	26
1.1 Metacognitive goal.....	26

1.2 Mentoring goal.....	26
1.3 Task goals.....	26
2. Interactive Goals.....	26
2.1 Mentoring sub-goals.....	26
Critical thinking sub-goals.....	26
Co-construction of knowledge sub-goal.....	27
Creative thinking sub-goals.....	27
Motivation sub-goals.....	27
2.2 Metacognitive sub-goals.....	27
3. Communicative Acts.....	27
4. Relations between acts.....	28
5. Other categories.....	28
Appendix 3: Sample transcription from corpus (session 1).....	29

1. Introduction

A key requirement for any dialogue analysis framework in Artificial Intelligence in Education research (the field to which the work described here belongs) is to provide categories of goals and actions that are sufficiently expressive to describe the necessary educational interactions, while at the same time being sufficiently constrained to give computational advantage from their use. A rich source of data for analysis can be obtained by studying human teachers. However, a very basic question raises its head: what exactly are studies of dialogue going to give designers of Computer-Based Learning Environment (CBLE)? Although it is difficult to extrapolate from human-human interaction what can be simulated for human-computer interaction, such studies can expand our knowledge of the detail of how a human teacher interacts. Commonly used goals and actions to achieve those goals can then be simulated in a CBLE on the basis of empirical data.

This report gives details of research that aims to meet the key requirement stated above. By analysing a small corpus, the work detailed below aims to begin to uncover the educational structure of a small aspect of music composition teaching (transforming a musical phrase). Specifically, the analysis of dialogue data aims to answer the following research question: *what are the interactive means by which a music composition teacher stimulates creative reflection?* Creative reflection is an overall pedagogical goal and is defined as the ability of a learner to make accurate predictions and imagine opportunities in novel situations. The teacher also had a pedagogical goal of mentoring: an intention to support the co-construction of knowledge and motivation to learn, to provide challenge through critical thinking and vision through creative thinking. The report concludes by outlining how findings are currently being used in the design of a mentoring agent.

1.1 Motivating examples of creative reflection

Creative reflection is reflection about predictions, but in the context of doing something creative (i.e. musical composition). Consider the abilities of Mozart, he was reputed to have been able to 'write in his head' a whole composition and then transcribe it onto music manuscript paper 'first time'. Even though the latter claim may now have become entangled in the Mozart legend, as Margaret Boden (1990) has pointed out, although some quotes may be incorrectly attributed to Mozart, there is evidence to support aspects of what he is reported to have said about his own creativity:

The lines [in quotes attributed to be by Mozart] about conceiving the music 'in its entirety' are [however] especially plausible. A variety of evidence suggests that Mozart, and many other H-creative people [historically-creative], could indeed imagine an entire conceptual structure 'all at once' (as we say) ... Mozart,

apparently, could be simultaneously aware both of a composition's articulated inner structure and of its overall form. (Boden, 1990, , p. 251)

That is to say, Mozart had the cognitive ability of being able to make accurate predictions and imagine novel opportunities. Creative reflection therefore involves being able to see the 'big picture' (the composition) as well as being able to understand what effect a small change to a few notes will have on the larger composition. Below is an example of a student making a prediction about how a phrase she has written would sound when played back (taken from session 3 of the study described below, the teacher has just asked her to describe the piece she had just written):

Emm, the first one [part of the phrase] is just coming down in semi-tones, so it's going to be the motif coming down a semi-tone each time. The next one I've done it so it leaps down back to the original, the middle C. Then up ... back to the original, down again and up back up, so it's like a see, see-saw ... Umm, the next one's [phrase] just coming down in a tone each time rather than a semi-tone. But, starting from a higher pitch.

By getting the student to verbalise how she predicted the piece would sound the student subsequently appeared to have built up a stronger image of her imagined opportunity. After the above prediction the teacher asked the student if she was comfortable with the first section of her piece, she replies 'no' and made suggestions for improvements. Although we can not expect every student to have the abilities of Mozart, it is fair to expect them to practice their abilities of creative reflection. Mozart was put through a strict musical training programme by his father from a very early age, which may in part account for his 'genius':

From his very earliest years under the tutelage of his father, his life was filled with music ... it seems to have been the only thing he [Mozart] was interested in (hence much of Salieri's exasperation).

But Mozart was not merely interested in music: he was passionate about it. In general, motivation is crucial if someone is to develop the expertise needed for H-creativity ... Even Mozart needed twelve years of concentrated practice before he could compose a major work, and much the same seems to be true of other composers ... In short, a person needs time, and enormous effort, to amass mental structures and to explore their potential. (Boden, 1990, p. 254)

In summary, the process of creative reflection is one of teacher encouraging the student to verbalise, i.e. give a self-explanation (Chi, Bassok et al., 1989; Chi, de Leeuw et al., 1994) in the form of a prediction about how a phrase just created will sound when played. The claim is that this (the effort of giving the explanation) will lead to student understanding of how to restructure her current prediction to incorporate a newly imagined opportunity. To become competent at creative reflection, therefore, involves increasing success by the learner at the elaboration of detailed structures of musical phrases, and hence motivation to practice the building of these structures.

1.2 Related literature

Using dialogue data to inform CBLE or ITSs (Intelligent Tutoring System) design is not, of course, a new idea. The WHY system (Stevens, Collins et al., 1982) represented an attempt, based on an informal study of human tutoring, to formalise the Socratic method for tutoring about the rainfall processes. However, the topics chosen to implement in WHY typically had a rule oriented cognitive structure. It is therefore unclear as to whether the approach is applicable to open ended creative domains such as music, which may have a different structure. More recently Collins and Stevens (1991) have used dialogue analysis to evolve a domain independent theory of inquiry teaching. They looked at Arithmetic, Art history, Law, Medicine, Geography, Moral education and Botany. Their theory has three parts: (i) the goals and subgoals of the teacher, (ii) strategies used to realise goals and subgoals, (iii) the control structure for selecting and pursuing different goals etc. The inquiry approach taken is one of:

forming a hypothesis, testing the hypothesis, making predictions, selecting optimal cases to test a theory, generating counter examples and hypothetical cases, distinguishing between necessary and sufficient conditions, considering alternative hypotheses, knowing what questions to ask, and so on. No system is implemented although the TAP system (Wong, Looi et al., 1995) has implemented a dialogue planner based on Collins and Stevens' theory of inquiry teaching.

McAdams and Bigand (1993, p. 4) have pointed out that although the psychology texts do cover problem solving and reasoning, the coverage is never related to "auditory problem solving as might be involved in musical composition". Creative reflection is more than making accurate prediction in say Physics, where if you have a model of the domain you can then make predictions (inferences) about what will happen in certain circumstances. Creative reflection adds the requirement for creativity. Science text-books have a tendency to treat scientific knowledge as settled. A student learns standard approaches to problem solving. The student is then given problems that vary from the model to see if they are able to extrapolate from that model of how things should be done to solve the problem in hand. In the humanities and arts, however, Matthew Lipman (1991) has suggested that the subject matter itself is

treated as essentially problematic and that it is more a question of problem seeking than problem solving (Lipman, 1991, p. 175). Lipman is probably correct in his assessment of many science text-books, which tend to say here is theory x, which has replaced theory y as a way of interpreting the physical world. However, Lipman is perhaps too brief in his argument and does not mention recent changes in science and maths teaching (see (Schoenfeld, 1985; Hartley, Byard et al., 1991) for example). Nevertheless, I do think that Lipman has a point and have extended this notion (Cook, 1994a) by proposing that in creative reflection about problem solving the first stage is often to problem seek, i.e. to define, formulate, find, invent, or create the problem before a method for arriving at a solution can be identified.

Earlier qualitative studies (Morgan, 1992; Cook, 1994b) have found that learners tend to have (i) poorly developed memory of the structure of a musical piece that they are creating or (ii) of a piece they have just heard. These findings acted as motivation for the design of the CBLE called Coleridge which is used in the study described in this report. Sitting at the computer and using modern computer-based sequencer programs to compose with may be part of the problem (students let the computer do all the work and do not develop creative reflection abilities and/or memory recall of structure abilities). Composing is a hard cognitive task, you need an overall conception of what you are trying to achieve and to be able to move from small to big picture There is agreement (Sloboda, 1985; Davidson and Welsh, 1988; Colley, Banton et al., 1992) that some 'superordinate' structure or reflective cognition guides the psychological activity of musical composition, i.e. a process where considerations of large-scale structure and plan guides the choice on a note by note basis. A composer also needs to consider how the listener 'hears' what has been composed (if they wish to communicate musical ideas to a wider audience at any rate). Having an overview of the big picture can prevent a composer from getting stuck with a motif, stop the composer going down blind alleys, help the composer decide when to throw away a bad idea or keep a good idea, help the composer come up with a coherent piece. Therefore there appears to be a need for 'tools' to overcome the barriers created by non-reflective composing. The report concludes by outlining how findings from the study are currently being used to inform the design of such a tool: a computer-based mentoring agent for promoting creative reflection.

2. Theoretical approach

The Knowledge Mentoring framework (Cook, 1996) for dialogue analysis detailed in this section approaches analysis from the perspective of goal hierarchies and communicative acts. The general approach taken to analysis is to take a dialogue, divide it into utterances, and then formalise each utterance into a goal and 'communicative act' (Baker, 1994) (communicative rather than 'speech' act since communication can also take place by non-linguistic means). The three levels of the framework are:

1. Pedagogical Goal (PG) Level: Overall PG goal = creative reflection. Lower level PG goals = metacognition, mentoring (which itself has PG level sub-goals = co-construction of knowledge, motivation, creative and critical thinking) and task goal (e.g. reflect on the inner-structure of a musical pattern).
2. Interactive Goal (IG) Level: e.g. critical probing; metacognitive monitoring & reflection.
3. Communicative (CA) Act Level: e.g. assert, question, offer, accept, reject .

The basic structure of the theoretical framework is shown in Figure 1.

A goal is defined as a planful activity and a commitment to a near-future state to be achieved. The overall pedagogical goal is creative reflection. The creative reflection goal can be met by a combination of range of lower level pedagogical goals that are devised to achieve creative reflection. Creative reflection can be (partially) achieved either:

by one of the four mentoring goals, or
by the metacognitive goal, or

by task goal

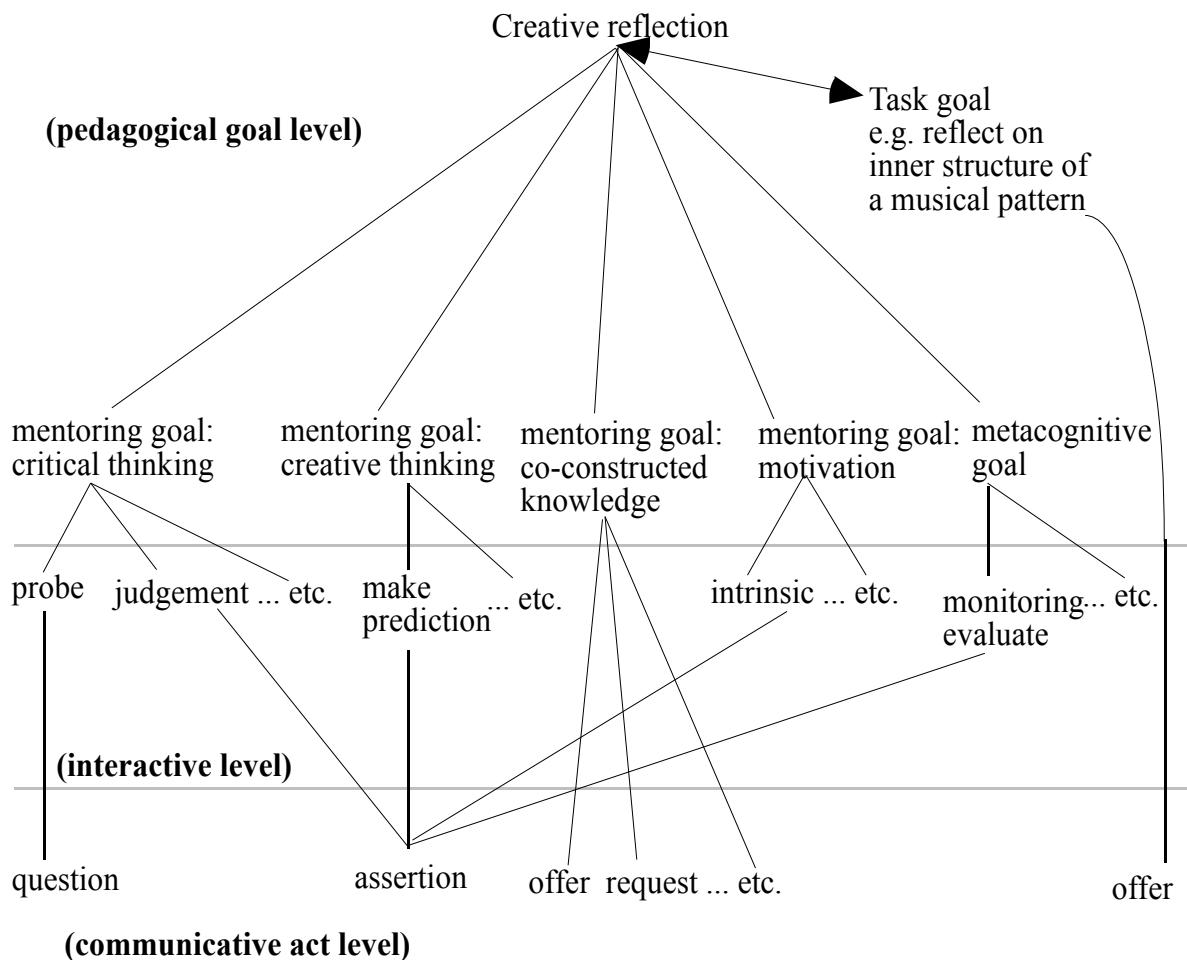


Figure 1: Theoretical framework

All of the above lower level pedagogical goals are interrelated and will be used in combinations to achieve the overall pedagogical goal of creative reflection. Creative reflection is defined here as the ability of a learner to make accurate predictions and imagine opportunities in novel situations. Creative reflection as defined is a constrained metacognitive activity that specifies the requirement for specific related 'metacognitive control' processes (Schraw and Moshman, 1995): planning-ahead (making accurate predictions), imagining opportunities (creativity), and monitoring (evaluation and diagnosis). An example of 'imagining opportunity' would be a learner utterance, with respect to a musical phrase, like "I think I'd like to make it a bit more chromatic actually". Success at creative reflection can be gauged by achieving a match between a learner prediction (e.g. a description of what will happen if a series of transpositions is applied to a motif) and the outcome of actually applying some novel transformation (e.g. how the phrase sounds when it is played). By asking the learner to become aware of their own metacognitive knowledge and control we are essentially asking the learner to develop what Schraw and Moshman have called a formal metacognitive theory of their own:

"Formal theories consist of highly systematized accounts of a phenomenon involving explicit theoretical structures such as those encountered in university classes in physics, music, or statistics ... One potential advantage of formal metacognitive theory is that it allows the individual to make informed choice about self-regulatory behaviours." (Schraw and Moshman, 1995, p. 361)

The definition of creative reflection has some similarities with the metacognitive process of 'reflective access' (Brown, 1987; Self, 1993), which includes the need for accurate predictions, except that creative reflection adds the requirement for novelty. Novelty as part of creativity is a contentious issue (Boden, 1990, p. 30). However, creative reflection is more than 'mere novelty'. As part of the learning process creative reflection is viewed here as a prerequisite ability that allows for the potential of 'genuine creativity' in musical composition.

Lower-level pedagogical goals include (i) metacognitive goal (ii) mentoring goal and related sub-goals, and (iii) task goal. Pedagogical goals and sub-goals can be met by a range of interactive goals or directly by communicative acts. Communicative acts are at the leaf level of the hierarchy, and can be used to realise, with different contents, most of the upper level interactive or pedagogical goals. The top two levels, the focus of this report, are now discussed in more detail below.

Metacognition as a pedagogical goal extends Self's (1993) DORMORBILE architecture for reflection, monitoring and reflective access in that it has the interactive goals of monitoring and reflection. DORMORBILE (DORmain, Reasoning, MOnitoring and Reflection Basis for Intelligent Learning Environments) is a conceptual architecture that distinguishes four levels of agent knowledge for student modelling purposes. We have proposed (Cook, 1996) that there is a set of goals that have 'implicit intentions' that will vary in their purpose, depending on the level in the learner being targeted:

- Some of which are designed to promote Reflection (Ref) in a learner, e.g. What else could you do with it? Can you generalise this to another area of your compositional work? (Goal = 'target M or Ref')
- Some of which are designed to set up Monitoring goals (M) in a learner, i.e. to help them assess the progress of their own learning. E.g. Is that what you intended? (Goal = 'target M or Ref')

Reflection (Ref) by a learner may not always be translated into a communicative act and hence poses a serious problem for dialogue analysis, a pause or some musical action may be indicative of reflection depending on the context. Monitoring goals (M) are usually achieved by communicative acts that are either evaluative (e.g. 'that doesn't sound right') or a diagnostic utterance (e.g. 'I got my counting wrong').

In a formal learning situation, "mentoring functions can be understood as variously providing *support*, *challenge*, and *vision*." (Daloz, 1990, p. 223). The mentoring goal draws on the work of Lipman (1991) and has the overall intention of supporting the co-construction of knowledge and motivation to learn, to provide challenge through critical thinking and vision through creative thinking. Mentoring goals are achieved by interactive goals, i.e. through dialogue. Dialogue has a particular meaning in Lipman's community of inquiry, the educational theory used to underpin the mentoring

pedagogical goal:

"A community of inquiry is a deliberative society engaged in higher-order thinking. This means that its deliberations are not merely chats or conversations; they are logically disciplined dialogues. The fact that they are logically structured, however, does not preclude their providing a stage for creative performance."

The overall intention of the mentoring goal is to achieve a community of inquiry dialogue, as defined above, by using interactive goals. Interactive goals are the goals that serve the mentoring goal. In critical thinking (a lower level pedagogical goal) probing (an Interactive Goal or IG), for example, is the asking of questions of a higher-order thinking nature. The Communicative Act (CA) 'question' is the utterance that serves the probing goal (IG), but not all questions (CA level) are probing (IG level), hence the separation is maintained (see section 4.2.1 for a definition of probing). One aim of this research is to identify incidents in the data where, for example, probing causes metacognition, etc.

Explaining the nature of a task goal would be achieved by communicative acts.
Actually

attaining task goals would be achieved by mentoring and metacognitive goals. This relationship between task goals and creative reflection is shown in Figure 1 by the double-headed arrow between the two goals. In dialogue, there will be an underlying task structure from which, at certain points, creative reflection sub-goals branch off or become achievable. For example, at one point a creative reflection goal may be dominant (e.g. mentoring goal-critical thinking, interactive sub-goal-probing), however, the discourse segment purpose (Grosz and Sidner, 1986), i.e. the goal of this segment of dialogue, may in fact be to get the student to think about or adopt the desired task goal, e.g. use interval leaps to transpose the motive. Once the student is pursuing task goal, other creative reflection goals may then become applicable.

Communicative acts take as a starting point Speech Act theory (Austin, 1962; Searle, 1969), which is usually taken to mean the illocutionary act: the performance of some speech action indicating an act that the speaker makes in relation to another (e.g. an assertion or question). A speech act has an intention behind it and is in itself a goal to change the other agent. Thus speech acts are applied to dialogue from the standpoint of intention (which more recently means any agent may be regarded as both a producer and an understander). Because speech acts do not cover written or musical actions 'communicative acts' have been used to extend their applicability. Baker (1994) describes a model for negotiation, based on analyses of teacher-student and learner-learner dialogues. Baker's model of the negotiation process is based on communicative acts and a set of different types of relations between offered propositions. Baker argues that the propositional attitude most relevant to negotiation dialogues is *acceptance* rather than *belief*. The common goal of negotiation is to reach an *agreement* where (i) negotiating agents may have individual and competing goals, (ii) negotiations consist basically of sequences of *offers* that may be *accepted* or *rejected*, and (iii) two possible negotiation strategies are to refine the original offer towards agreement, or to keep an offer fixed and to attempt to persuade the other to accept by *argumentation*. 'Offer' as a communicative act in the framework described below keeps the essence of Baker's negotiation in that they can be accepted or rejected. However, in our framework there is less negotiation about what to do and more emphasis is placed on how to proceed with a task if accepted. In this respect 'offer' in our framework has some similarities with 'offer' in Fox's (1993) approach.

In summary, at the pedagogical level, the overall goal is to promote creative reflection by pursuing mentoring, metacognitive and task lower-level pedagogical goals. A pedagogical sub-goal (e.g. the mentoring sub-goal 'critical thinking') would plan an intervention by selecting an 'appropriate' interactive goal (e.g. probing). Interactive and task explanation goals are achieved by communicative acts. The probing goal (IG) would usually select the communicative act 'question' form, since the overall intention is to promote metacognition in the learner. One of the purposes of dialogue analysis is to help us understand what a teacher takes to be 'appropriate' and to uncover why it was deemed 'appropriate'.

3. Empirical study based around a CBLE: Coleridge

3.1 Coleridge

Coleridge (Cook and Morgan, 1995) is a CBLE design to provide fast playback of musical ideas, thus freeing up time for dialogue and metacognition. Coleridge is built in a Common Lisp based music composition language called Symbolic Composer (Morgan and Stone, 1995). A annotated screen-shot of Coleridge is shown in Figure 2.

The technique used in Coleridge for transposing a given pattern (e.g. C C# F# G) is simply to use a transposition number (which represent semi-tone steps, i.e. pitch transposition). By creating a list of transposition numbers in relation to a base position (value 0) a musical phrase or section may be produced. Zero will just simply give a repetition of the pattern (C C# F# G), -7 gives a transposed down repetition of the pattern (F F# B C), -12 plays the

whole pattern an octave lower, and so on. The 'MIDI-file player palette' shown in Figure 2 can be generated for a list of transpositions by clicking on a 'Compile Button'. Compiling a list thus produces a phrase or section ready for playback.

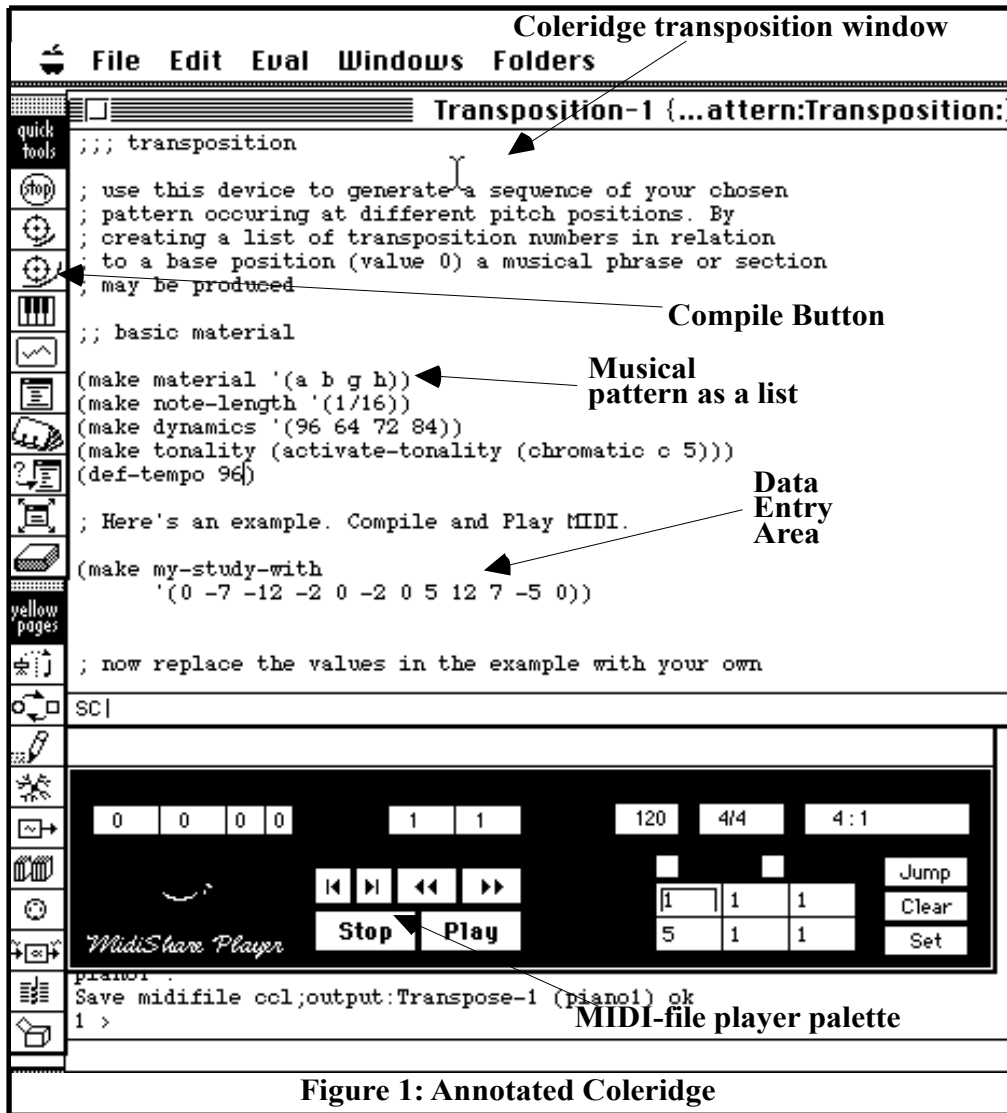


Figure 1: Annotated Coleridge

Figure 2: Annotated screen-shot of Coleridge

3.2 Research Method

This research does not take a Quantitative approach (where we would vary the way the teacher causes learning and check any learning gains by pretest, posttest and control group). The reason for not taking a quantitative research method is that, although it may say 'yes this intervention seems to work in these circumstances', it does not tell us how to take that intervention and get the computer to do something similar. The detail required for teaching agent design is simply not made available. The research method that was used for this study was a 'hybrid' qualitative one, involving observation,

interviews, data transcription, and data analysis to generate quantitative data. The qualitative method can be characterised as follows:

Qualitative implies that the data are in the form of words as opposed to numbers. Whereas quantitative data are generally evaluated using descriptive and inferential statistics, qualitative data are usually reduced to themes or categories and evaluated

subjectively. There is more emphasis on description and discovery and less emphasis on hypothesis testing and verification. According to (Polkinghorne, 1991, p. 112), **qualitative methods are especially useful in the generation of categories for understanding human phenomena** and the investigation of the interpretation and meaning that people give to events they experience. (Rudestram and Newton, 1992, p. 31, my bold)

Whereas the quantitative method is suitable for recording a small set of previously identified variables, the qualitative method can assist in uncovering a psychologically rich, in-depth understanding of the 'interactive means by which a music composition teacher stimulates creative reflection' (the research question for the study). I would argue that experimental and quasi-experimental qualitative methods cannot do justice to describing the phenomena that this research wishes to investigate (interactive teaching and learning). However, the qualitative approach taken, and the data analysis using computer-assisted methods (HyperRESEARCH™, a qualitative analysis software package) did generate quantitative data. In this respect the research method taken in the study was a 'hybrid' qualitative method.

Interviews were also used as part of the study to provide answers to pre-set questions and to elicit elaborations on 'incidents' in the interactions that the researcher/observer found interesting. In the study described in this report, the researcher and interviewer (me) took detailed notes, as the session progressed of dialogue that seemed interesting (e.g. dialogue that seemed aimed at promoting the goals of reflection and monitoring). These notes were used as cues (Ericsson and Simon, 1993) in the form of questions in the post-experimental interviews with the learners and the teacher. (See Appendix 1, §6 for details.)

The study had two purposes with respect to overall research method of the larger research project that the study forms a part:

- It takes a 'design stance', in that by filtering the 'behaviour' of a teacher (who adopts a mentoring approach) the study is attempting to identify the range of teacher interventions that have the goal of stimulating creative reflection and identify interventions by the learner that indicate creative reflection has occurred. The purpose of the detailed analysis of dialogue data is to then uncover a correlation between a teacher's intention and intervention for creative reflection and the student's attempts at creative reflection.
- The study was also about dialogue modelling, a model for mentoring is being evolved, based on work by Self (1993) and some contributions by myself (e.g. the categories described in section 4, and the very detailed data analysis that says how the teacher uses these categories to promote creative reflection in the learner).

3.2.1 Data transcription

Data was transcribed using a technique described in Cook (1996, p. 203), which is

essentially based on a protocol transcription method used by Fox (1993). What follows is an almost verbatim description of parts of her approach, although in my analysis an utterance could be verbal or musical.

// indicates the place at which a speaker's utterance is overlapped by the talk from another speaker. Utterances that are overlapped more than once have more than one double slash in them, and the utterances that do the overlapping are given in sequential order after the overlapped utterance.

[at the beginning of a line indicates that two utterances (the ones above and below the symbol) began simultaneously.

= indicates latching, that is the next speaker begins without the usual "beat" of silence after the current speaker finishes talking. In this case there is an equal sign at the end of the current speaker's utterance and another at the beginning of the next speaker's utterance.

=[indicates that the utterances above and below simultaneously latch (talk at once).

(0.8) numbers given in parentheses indicate elapsed silence, measured in tenths of a second. Only pauses of (0.9) upwards for reflection and (0.7) for 'complete' categories (see Appendix 2) were recorded.

Punctuation is used to suggest intonation; italics indicates stress. A colon after a letter means that the sound represented by that letter is somewhat lengthened; a series of colons means that the sound is increasingly lengthened.

The letter *h* within parentheses indicates "explosive aspiration," and usually means some type of laughter is being produced. A series of *hs* preceded by a dot represents an in breath.

Questionable transcriptions are encoded within parentheses (i.e. it is not clear who made the utterance).

'[]' brackets with capitalised words enclosed represents non transcribed material (i.e. music or noises that are non-linguistic).

">" indicates rising, but not terminal rising, intonation, as is often found at the end of each member of a list.

Appendix 3 give a sample from the transcribed corpus. Note that as an aid to clarity, the corpus includes replica screen-shots of student work (i.e. created after the sessions from the video recording of the state of Coleridge).

3.3 The study

The study took place at a British University College in November 1996. See Appendix 1 for a full description of the study. The aim of the study was to answer the following research question: what are the interactive means by which a music composition teacher stimulates creative reflection? Four teacher-learner sessions were conducted with third year BA Combined Studies students (each of who were taking a music pathway and an electro-acoustic module). Out of a total of four students, three were male and one female. Each learner-teacher session lasted about 30 minutes and was recorded on two video cameras and audio tape. Teacher and student sat in front of a 'composer workstation' which consisted of a Power PC with Coleridge installed, an electronic keyboard and a mixing desk attached to speakers. The learners were interviewed immediately after a session for 15 minutes. The teacher was then interviewed for 15 minutes. The following instructions were given to the teacher a few weeks before the session: 'Please interact with the students for 30 minutes and try to promote the learning outcome of creative reflection by using a process of mentoring (the teacher was familiar with these terms but was nevertheless given definitions). Use

the task described below and Coleridge as the basis for interaction with the students.'

The task was to ask the learner to generate, by transposition of a 4 note pattern, a musical phrase (more generally transformation of the pattern). Slonimsky pattern No 1 (1947), which is C C# F# G, was given by Coleridge at first. The overall tutorial task goal was 'reflecting on the inner structure of a musical pattern'. There were three task sub-goals associated with the overall tutorial task goal: to extrapolate an example of structural content from the Learning Agent's phrase, second to critically analyse the extrapolation, and finally that of placing this extrapolation in the context of a whole phrase.

The following goals were involved in the study:

- the teacher has a creative reflection goal
- the learner has task goals
- the teacher also has goals that the learner will achieve certain task goals

In that case, what we expected from the qualitative analysis was to see which task and creative reflection goals are being pursued at a given point, and what communicative acts the teacher uses to achieve them.

3.4 The corpus collected

In post-experimental interviews (see §6 of Appendix 1) the teacher and three learners said that they did not feel that the observation setting had exerted an undue influence on them. Learner 2 did feel that the observation setting had an undue influence on him. On the whole I conclude that the corpus collected was a reliable record of teacher-learner interactions. The students normally get composition tuition on a one-to-one basis and the sessions observed will not have been too unusual for them, a conclusion that most of the participant's comments appear to support. However, this must be weighed against the knowledge that being observed will tend to exert some change of behaviour on the object of observation.

4. Analysis approach

This section gives definitions of important categories used in the analysis of interactions and an example analysis. For a full description of ALL the categories see Appendix 2. All of the category names are shown in Tables 2-4.

4.1 Pedagogical goals

4.1.1 Metacognitive goal

Definition metacognition: "refers to understanding of knowledge, an understanding that can be reflected in either effective use or overt description of the knowledge in question." (Brown, 1987, p. 65). Metacognition has been tightly constrained in this study to be creative reflection.

4.1.2 Mentoring goal

Definition: Mentoring intends to support the co-construction of knowledge and motivation to learn, to provide challenge through critical thinking and vision through creative thinking. Three of the four lower-level goals are:

Definition Co-construction of knowledge: This refers to the participants' relationship or attitude to knowledge in that knowledge might be seen as an outside 'given' to be absorbed or transmitted, or on the other hand as co-constructed by teacher and learner, allowed to be queried, not 'true' for all time. The latter relationship to knowledge is taken in mentoring. [Mainly coded up using the communicative act categories.]

Definition Critical thinking: "... critical thinking is thinking that (1) facilitates judgement because it (2) relies on criteria, (3) is self-correcting, and (4) is sensitive to context." (Lipman, 1991, p. 116)

Definition creative thinking: the ability of a learner to make accurate predictions and imagine opportunities in novel situations.

4.1.3 Task goals

Definition task goal: This is a description of what the teaching and learning interactions will aim to achieve, it provides a statement against which learning outcomes can be measured.

4.2 Interactive Goals

4.2.1 Critical thinking sub-goal probing

Definition: This is the asking of questions of a higher-order thinking nature: "the question is a way of engaging the student in the directed practice dealing with a specific area of the problem at hand. The course of higher-order thinking may at appropriate moments be punctuated with pauses for such directed practice ... On the other hand, the focusing power of the question means that questions can be constructed that represent the points of view of

major figures in the discipline. One might even employ the occasion to enlist hypothetical questions from figures in other disciplines." (Lipman, 1991, p. 224-225). Probing can be a focused used of observations of a student's phrase. An example of probing by the teacher from the study was: "... these [USES CURSOR 'T' BAR TO POINT TO 28 AND 24] surprises that you mentioned, very large leaps. Umm. Do they, segment the music? Or do you, do you see that jump there [POINTS WITH FINGER TO 28] triggering this little phrase here?"

4.2.2 Creative thinking sub-goals

Definition creative imagine opportunity: Interaction (verbal and/or musical and/or actions) by either teacher or learner that concerns the mental imaging of a creative idea in a novel context. An example of 'imagining opportunity' would be a learner utterance like "I think I'd like to make it a bit more chromatic actually"

Definition creative make prediction: Dialogue by either (i) the teacher to elicit a prediction, or (ii) the learner that indicates that a prediction has been made about how an imagined novel opportunity will sound when played.

Definition creative accurate prediction: Dialogue by either teacher or learner that indicates that a successful prediction has been made about how an imagined novel opportunity will sound when played.

4.2.3 Metacognitive sub-goals

Definition target M or Ref: Some communicative acts may have the implicit intention of targeting the monitoring or reflection level of an agent (Cook, 1996). Usually it will involve the teacher's attempts to elicit verbal self-explanations (Chi, Bassok et al., 1989) from the learner about their own attempts at creative reflection. This goal is intended to help learners integrate new knowledge with existing knowledge. If the goal is accepted the agent can use it to monitor their progress, to imagine opportunities, etc. It is typically the asking of open-ended questions.

Definition monitoring evaluate: Dialogue that involves some evaluative comment about the match between a prediction and an outcome is indicative of monitoring.

Definition monitoring diagnose: A second type of monitoring will involve an attempt to diagnose why something did or did not work.

4.3 Communicative Acts

Typically in speech act theory (Searle, 1969) we have assertions, questions and requests, which do not cover all written or musical acts. By drawing on work by Baker (1994) and Fox (1993) the communicative acts categories have extended these basic "speech acts" to include the notions of offer, accept and reject. These three communicative acts are supplemented with other acts and relationships between acts.

4.4 Allocation of an utterance to categories

An important point to note is that in the data analysis the same utterance may be

allocated to more than one category (if more than one level in the hierarchy shown in Figure 1 is involved). If the occurrence of a goal is identified in the data it is coded only once and a communicative act is also associated with that utterance. The following interactions that aim to meet that goal are coded as communicative acts only (until a new goal is encountered or the old goal is encountered in a 'new' format). However, the motivation goal is an exception to this rule (each occurrence as an utterance is recorded). Utterances that did not easily fit into one of the categories defined were coded other.

4.5 Example of dialogue analysis

Table 1 gives a sample analysis taken from session 4 of the study described in Section 3.3.

Table 1: Example of dialogue analysis from the study

TA = Teaching Agent, LA = Learning Agent

Agent-utterance	goal	act	other	commentary
TA1: What do you think?	target M or Ref	question TA		TA is asking LA if prediction he made earlier matches the phrase they have just heard.
TA2: [SCROLLS TO TOP OF WINDOW]	<TA1 goal still active>	-----	action TA	TA is making the data entry area of Coleridge visible so that LA can look at his list of transposition values whilst considering the question.
LA3: (1.0) It wasn't actually quite as (2.5) as I expected.	monitoring evaluate LA	assertion LA	possibly reflecting pause x 2	There are two reasonable pauses (in brackets, measured in seconds) for monitoring. The learner makes an evaluative comment that the phrase was not quite what he had expected.
LA4: But doesn't mean that=	-----	-----	incomplete utterance LA	The '=' on the end of the utterance is called latching and indicates that the normal beat of silence is not left by TA in next utterance following this utterance (TA5).
TA5: =What did you expect?	target M or Ref	question TA	-----	TA is persisting with this goal but with a different question (hence it is coded again as another instance of the goal).
LA6: Err, I got mi, I got mi countin' wrong // should be an 0 1,	monitoring diagnose LA	assertion LA	-----	Following questioning the learner attempts to diagnose what the problem may be. The '/' indicates that TA talks at that point over the top of LA with utterance TA8.
LA7: because I wanted it to have a sort of,	-----	-----	incomplete utterance LA	Although this is an incomplete utterance, LA does finish it off with action. The point he is trying to make becomes clearer at LA11.
TA8: Got your counting wrong.	motivation encourage- ment TA	assertion confirmation TA	-----	TA is motivating LA to keep explaining by giving a repetition of an assertion previously made by LA. The teacher is confirming student's assertion, which was a form of self-assessment (the monitoring diagnose at LA6).
LA9: [PLAYS SCALE ON KEYBOARD: C C# F# G A A# D D#]=	-----	-----	action LA	The learner then plays something on the piano. Again, the point he is trying to make becomes clearer at LA11.
TA10: Yeah, so that's =[-----	-----	incomplete utterance LA	The '=' means the utterances above and below simultaneously latch (talk at same time after LA9).
LA11: I didn't want it to play the same note twice.	creative imagine opportunity LA	assertion LA	-----	The learner explains that his problem definition is that of 'not playing the same note twice'. Later, after some debate, the 7 in the transposition list was changed to a 9, (not shown) and TA comments favourably on the novelty of the learner's idea, hence this is coded 'opportunity' rather than 'predict'.

5. Results of analysis

Data was analysed using the framework described above with the assistance of HyperRESEARCH™, a qualitative analysis software package. The results of the analysis of the data are shown in Tables 2-5 (where TA = Teaching Agent and LA = Learning Agent).

Table 2. Metacognitive goals and task goals

Metacognitive goals	LA	TA	total	Task goals	LA	TA	total
target M or Ref	3	27	30	task	8	41	49
monitoring evaluate	40	3	43				
monitoring diagnose	12	1	13				
reflect predict	4	0	4				
reflect imagine opportunity	8	1	9				

Table 3. Mentoring Goals

Critical thinking	LA	TA	total	Co-construction knowledge	LA	TA	total
critical judgement	2	28	30	listen to others	0	1	1
critical probing	0	44	44	[rest coded up using Table 4]			
critical challenging	0	3	3				
critical clarification	25	4	29				
critical give reasons	9	3	12				
critical give evidence	2	2	4				
Creative thinking	LA	TA	total	Motivation	LA	TA	total
creative imagine opportunity	26	13	39	motivation intrinsic	0	11	11
creative make prediction	9	6	15	motivation extrinsic	0	4	4
creative accurate prediction	1	2	3	motivation encouragement	7	69	76

Table 4. Communicative Acts, Relations and Other

Communicative Acts	LA	TA	total	Other	LA	TA	total
assertion	243	237	480	pause	25	---	25
assertion confirmation	106	186	292	action	87	344	431
question	41	150	191	other	---	---	18
request	11	62	73	continuation	---	---	17
offer	6	70	76	dialogue management	20	23	43
offer continue	2	34	36	incomplete utterance	37	35	72
accept	51	28	79	not accept yet LA	13	---	13
accept confirm	20	3	23	possibly reflecting LA	26	---	26
reject	3	5	8	retraction	---	---	1
Relations	LA	TA	total				
complete	11	0	11				
transform	0	9	9				

6. Discussion

The data has yet to be subjected to inter-coder reliability checking and only four subjects were observed. However, given these reservations some initial findings relating to the overall

pedagogical goal of creative reflection can be reported (many of the findings relating to other aspects of the framework, like communicative acts are beyond the scope of this report).

1. The first comment to make about the results is that students do not seem able to make accurate predictions, in spite of tutor support and a computer environment design to assist this process. Students did make some attempts at making a prediction: Table 3 shows 9 attempts by the learners at 'creative make prediction'. However, Table 3 also shows that only 1 (out of 4) learner met with success at making an accurate prediction. One possible reason for this may be that, because this form of (metacognitive control) training was new to the students, it was only by the end of the 30 minute sessions that students had become accustomed with the idea of thinking forward and making predictions (planning). If these students were allowed to take a second session, then I would predict that the score for 'creative accurate prediction' would increase. This would be an interesting line for further research. The ability to make an accurate prediction is clearly difficult and may require repeated practice and guidance. It is therefore claimed that there is a real learning need for a computer based 'mentoring' component in Coleridge that will assist students who wish to practice their abilities of creative reflection.

This claim was supported in comments made in post-experimental interview with the teacher following the third session, where the teacher is commenting on a task he had set the learner at the end of the session (after hearing one of TA's compositions the learner was asked to describe the structure of the piece she had just composed, I = Interviewer, i.e. me):

TA: Umm, and I mean the other point to make, I haven't said this openly to the students, but the whole business of memory is key.

I: Yeah, in our conversations and that's an interesting piece of evidence in that her memory is still not that well developed, is it?

TA: No, it isn't. Yeah, she left out that whole section.

I: Yeah, and part of a section ...

[AND A LITTLE LATER]

TA: Yes, but you see the interesting thing about this [THE SESSIONS] is that you could never do this in a class session. You could never do, you would never dream of doing this kind of thing in a tutorial. You just wouldn't do it. Because you couldn't, it would be very difficult to justify it in a course programme. But within, emm self-supported study programs.

I: If you got a little advisor that helps, gives you // tips on how to do it. And there's definitely a learning need there for it. And that's what computers are good at.

TA: Yeah, oh yeah.

TA: That's right.

I: And if you can get the computer to do some tracking of what they are doing and make some // half-way sensible sensible suggestions

TA: Now that's yeah.

I: Yeah, quite a bit of programming involved but err.

TA: But it shouldn't be difficult because your, I mean your working with numbers here.

I: Yeah, and lists.

TA: And lists.

I: If you could keep to that. they don't seem too worried about the lists do they, the students, they seem to be able to.=

TA: Oh no no, I've, well.=

I: =Tell me, just tell me how much Symbolic Composer you've used with the students.

TA: None. Never used it.

I: None of them at all.

TA: Oh no they won't have seen it until today.

I: They've just used the sequencer, so there not used to working in lists.

TA: Oh no.

The above illustrates that a Coleridge mentor agent:

- could meet a learning need for practice at creative reflection , and that
- meeting this learning need may be a task that a human may have trouble providing justification for in UK's busy curriculum, and that
- students are not too troubled by the fact that they are working with numbers (rather than say the stave and musical notation).

A focus for the mentor could be on the potential that the choice of intervals provides for music to be sectionalised into phrases. This seemed relevant to all the students (who varied in ability).

2. However, Table 2 does show some monitoring by the students (40 'evaluate' and 12 'diagnose'). This finding is encouraging in that mentoring seems to promote the monitoring effect, which we would claim is the first step towards creative reflection, and in particular the ability to make accurate predictions. Table 4 also shows that there were 26 occasions that were coded as 'possibly reflecting LA' (which is where the context strongly suggests that pauses are indicative of cognitive activity related to monitoring type creative reflection). Furthermore, the occurrence of pauses that were considered to be indicative of some form of 'reflection' in a broader (related to critical goals or questioning acts) sense was 25. (Note that the latter two scores excludes 'reflect predict', 'reflect imagine opportunity', and pauses related to 'complete'.)

3. Table 3 shows that some attempts were made by learners at 'creative imagine opportunity' (26). The 8 'reflect imagine opportunity' in Table 2 are related to the 'creative imagine opportunity' in that they are pauses, or utterances like 'umm', where the learner reflects about an opportunity before actually using an interactive goal to state what that opportunity is. The mentoring approach taken and the support given by Coleridge appears to have encouraged some learner creativity. This finding is supported by the teacher's remarks made in interview about the novelty of some of the ideas generated by students.

4. By examining the 6 utterances (excluding actions, except data entry by LA) preceding each of the 26 occurrences of 'creative imagine opportunity' by LA, it was found that

- 16 out of 26 occurrences of 'creative imagine opportunity' were preceded by 'target M and Ref' by TA.
- 11 out of 26 occurrences of 'creative imagine opportunity' were preceded by the combination 'target M and Ref' by TA and 'monitoring' of either type by LA.
- 9 out of 26 occurrences of 'creative imagine opportunity' were preceded by the sequence 'target M and Ref' by TA followed by 'monitoring' by LA.

Other less common variations included the use of the critical goals that led to 'creative imagine opportunity'. In particular, 'critical probing' by TA, in combination with 'target M or Ref' eventually led to the only occurrence of 'creative accurate

prediction' identified in the analysis.

5. By examining the 6 utterances preceding each of the 12 occurrences of 'monitoring diagnose' by LA, it was found that

- 4 out of 12 occurrences of 'monitoring diagnose' had 'target M and Ref' (with associated 'question' communicative act) preceding it
- Another 4 out of 12 occurrences of 'monitoring diagnose' had the 'questioning' communicative acts on its own preceding it.
- 6 out of the 12 occurrences of 'monitoring diagnose' were preceded by 'monitoring evaluate' by the student.

This point is well illustrated in Table 1 where each of the two occurrences of 'target M and Ref' lead to student monitoring (this sequence was identified in 3 of the sessions).

In summary, results of the analysis suggest that (i) because learners seem unable to make

predictions about how a phrase will sound, there is a real learning need for a mentoring agent for Coleridge, (ii) mentoring and Coleridge promote monitoring and creativity, (iii) when asked questions learners tend to use the strategy of 'evaluate' the phrase and then 'diagnose' what is wrong with it, and (iv) 'critical probing' can lead to learners making accurate prediction about creative ideas.

7. Conclusions

Below some proposals are given for the construction of a computer-based mentoring agent. The proposals represent a brief description of how *some* of the dialogue analysis findings presented in this report are currently being applied to a mentoring agent for Coleridge (which is being implemented in Common Lisp). When implemented the mentor will be evaluated with students to see if the constrained number of commonly used goals identified above provide mentoring that helps learners practice their ability of creative reflection.

1. Motivation to practice creative reflection is important. If a human tutor asks for creative reflection then a learner may feel compelled to comply. However, if a computer asks for this then it is not clear if a student will undertake this 'hard cognitive task', they may just sit back and 'let the computer do the thinking' (Barnard and Sandberg, 1996). The first proposal, therefore, is to make the ability to demonstrate creative reflection part of the assessment strategy for a course of study, thus providing extrinsic motivation for the student to carry out the practice required.
2. A focus for the mentor will be on the potential that the choice of intervals provides for music to be sectionalised into phrases. Heuristics on how this is taught are evident in the dialogue data.
3. 'Target M or Ref' (the asking of open-ended questions, e.g. "Was that what you intended?", see Table 1 for examples) will be the default strategy for promoting 'creative imagine opportunity'. The mentoring agent will anticipate that the student will follow its intervention with 'monitoring' and then 'creative imagine opportunity'. If the mentor is unable to detect evidence of monitoring, for example, then repair strategies will be implemented to see what went wrong and attempt to achieve monitoring by the student.
4. When the user model indicates that a learner has achieved 'competence' at 'creative imagine opportunity' (measured as a result of systems requests for the student to make a self-assessment about their ability to come up with interesting ideas) then 'critical probe' will be used as an advanced strategy by the mentor to achieve accurate predictions by the learner. For example, in music a probing question would be 'where would you put the phrase boundaries in the piece you have just written'?

5. The mentor will offer the advice that learners should, when asked a question, use the strategies 'evaluate' then 'diagnose'. The mentor will be able to give examples of this sequencing of the strategies from the corpus.

Results obtained from an analysis of teaching and learning interactions in a constrained educational context have been used above to make specific suggestions for the design of a computer-based mentoring agent. But what aspects of the analysis have I chosen not to include in the design of the mentor? One omissions centres on the human mentor's ability to leave pauses for reflection (before prompting for example). The data suggests that this plays an important role in interactions that promote creative reflection. This research identified five categories of pauses, which were identified from their context: 'reflect predict' and 'reflect imagine opportunity' (which happen before or during communicative acts related to creative thinking interactive goals), 'possibly reflecting' (usually associated with communicative acts indicating monitoring activity), 'pauses' (related to communicative acts intending to achieve critical goals) and pauses related to 'complete' (where the mentor leaves a gap for the learner

to finish a statement). Although it may be a useful line of research, the barriers to computer-agent natural language understanding may exclude the option of making use of pauses in the short term (such an agent would require the ability to allocate to a learner a pause a meaning based on the context, not impossible of course but the focus here is on implementing commonly used goals). However, pauses did assist in the dialogue analysis, helping to pull out of the corpus the commonly used goals and the interactive means by which the human mentor promoted creative reflection.

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Appendix 1: Full description of the study

What follows is a full description of the planning for the study described in this report.

1. Introduction

The study took place at Liverpool Hope University College on Tuesday November 5, 1996. The aims of the formative study were:

- to gather data to answer the following research question: what are the interactive means by which a music composition teacher stimulates creative problem seeking and creative reflection?
- more specifically, to ascertain how a teacher initiates and adapts plans in a process of mentoring about the transposition of a motif.
- to provide some empirical data on the use of the categories outlined in the scheme described below.

Four teacher-learner sessions were conducted with third year BA Combined Studies students (each of who were taking a music pathway and an electro-acoustic module). Out of a total of four students, three were male and one female. Each learner-teacher session lasted 30 minutes and was recorded on video and audio tape. Teacher and student sat in front of a 'composer workstation' which consisted of a Power PC with Coleridge installed, an electric keyboard and a mixing desk attached to speakers. The learners were interviewed immediately after a session for 15 minutes. The teacher was then interviewed for 15 minutes. Data gathered was used to improve the design of Coleridge and inform implementation of an mentor component that enables compositional plans to be sketched from initial material.

2. Instructions given to the teacher

The following instructions were given to the teacher in advance of the session:

Please interact with the students for 30 minutes and try to promote the learning outcome of creative reflection by using a process of mentoring. Use the task described below and Coleridge as the basis for interaction with the students. For clarification purposes, the terms used in this statement are defined below:

- *Mentoring* means that you as a teacher should intends to foster the goal of *creative reflection* in the learner by a process of promoting mentoring goals in your interactions with the learner.
- Creative reflection is defined as the ability of a learner to make accurate predictions and imagine opportunities in novel situations. For example, assume a learner has just been told that chromatic transposition of a motif (e.g. sequentially by small interval values) produces a phrase with a trajectory. If that learner is then asked to suggest a series of intervals for the transpositions, to then make a prediction about how it will 'sound', and if this prediction matches the phrase when it is played then we have an example of creative reflection in a learning situation. Success at creative reflection, i.e. the ability to make accurate predictions and imagine opportunities, can therefore be gauged by achieving a match between a learner prediction (e.g. a description of what will happen if a series of transpositions are applied to a motif) and the outcome of actually applying some novel transformation (e.g. how the phrase sounds when it is played).
- Mentoring intends to support the co-construction of knowledge and motivation to learn, to provide challenge through critical thinking and vision through creative thinking. The exact meaning of these four interaction goals are left for your own interpretation. However, it is important to add that the interactions should assist the learner in the process of problem seeking, i.e. finding out for themselves how the elaboration of a given motif can assist in the formulation of a compositional idea.

If you have any prior knowledge of a student this should summarised and given to the observer in advance of the session. The teacher is requested to conduct all 'get to know the student' type interactions in the formal session. This is because the observer is watching for the use of this knowledge (about a learner) in planning and interaction.

Furthermore, on the day of the session the teacher asked me if there was any instructions I would like to add. I replied that he should not be afraid of leaving silent gaps at appropriate places for the student to reflect.

3. Information sheet for students

The following information sheet was given to the student in advance of the session

Reflective Learning in Music Composition

'I get up early , and as soon as I have dressed I go down on my knees and pray God and the Blessed Virgin that I may have another successful day. Then when I have had breakfast I sit down at the clavier and begin my search. If I hit on an idea quickly, it goes ahead easily and without much trouble. But if I can't get on, I know I must have forfeited God's grace by some fault and then I pray for more grace till I'm forgiven.'

For most composers the act of composition still continues to be the daily 'search' for ideas that it was for Joseph Haydn. And, in essence, the nature of that 'search' has probably changed little in 200 years. Patient reflection and deliberation that all composers crave continue to face up to the pressure of the deadline, and most particularly now in a student's earliest experience, of the composing activity - in the music classroom where it is considered a vital element in music education.

Such is this pressure to produce the next composition that we rarely give thought or time to deliberating on the nature and effectiveness of our thinking process. We slide into a way of working and often retain a method of 'getting things done' that can remain in place for years.

Despite the importance of composition to music education composers are rarely taught. They usually learn: from example, by analogy, by discovery and from their own failures. Instruction is rare, and 'method' frowned upon except as a last resort to produce an outcome. By composing we learn, but we rarely reflect about how we learn and even less about the nature and mode of our process of thinking.

Developments across the disciplines of computer science, artificial intelligence and education are seeking pathways to Intelligent Learning Environments which have the power, 'intelligence' and flexibility to contribute new learning styles and opportunities for aiding creativity. Music composition presents a particularly fascinating problem to researchers as the activity of composing tends towards the seeking and creating of problems before attempting to solve them in any way. There is also very little known about how composers think when they are actually composing.

Before such Intelligent Learning Environments can be modelled and built we have to explore practice in composition teaching: what is appropriate teaching? How and when should a teacher intervene in a student's deliberations on, or execution of, their composition? And, most important, what should be the form, content and justification for that intervention?

A good teacher does not elicit information or direction directly but questions the student in order to tease out answers or solutions from the student. The student is encouraged to think, consider, postulate, assess, appraise, examine, experiment and so on. Teaching interventions are all about finding the right question to ask at the right time.

The next step for the researcher is to monitor the effect a teaching intervention has on the student. Does the intervention simply produce an answer or solution or go beyond that to encourage the student to think and reflect more effectively for themselves? Using information gained from these and other questions the researcher begins to be able to build a picture of teacher-learner interaction. This may ultimately provide the foundation for an Intelligent Learning Environment that is able to reflect about the way it teaches.

Whatever the outcomes of such research for the computer scientist, AI specialist or educator the composer has only to benefit. The introduction of highly interactive computer applications for composition has tended to focus the composing activity more continuously on creating a succession of notes and sounds rather than encouraging the composer to reflect, plan, scheme or design. Improvisation rules, and composing becomes a chain of small-scale feedback loops . . . The outcome of this practice is that composers find that they can only think when inside this technology-induced feedback loop. Reflective thought becomes disabled when it has the potential for being with the composer constantly. Haydn may have needed to 'search' at the clavier but it's highly unlikely that he stopped thinking and reflecting about his music as he shut the door on his music room for the day.

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4. Task Design

The task was to ask the learner to generate, by transposition a 4 note pattern, a musical phrase. Slonimsky pattern No 1 (i.e. c5 c#5 f#5 g5) was given at first. The initial teaching plan was known by the teacher-composer and observer in advance. The overall tutorial task goal was 'reflecting on the inner structure of a musical pattern'. There were three task sub-goals associated with the overall tutorial task goal: to extrapolate an example of structural content from the Learning Agent's phrase, second to critically analyse the extrapolation, and finally that of placing this extrapolation in the context of a whole phrase.

5. Observer guidelines and questions for interview

5.1 Observer guidelines

Because the first aim of the session was to investigate the interactive means by which a music composition teacher stimulates creative problem seeking and creative reflection, in the post-experimental interviews the teacher and learners will be given cues gathered by an observer of the session. Post-experimental cues (Ericsson and Simon, 1993, p. xvi), see §5 below, act as an aid recall of thought episodes at specific points and will attempt to focus on issues of intentions, plans, dialogue goals and plan revision. The observer of the sessions (me) was particularly watching out for the following events to act as post-experimental cues:

- Incidents where the intention works, e.g. it appears to foster creative reflection.
- Occasions where the intention fails, e.g. a learner declines to accept the tutorial task goal.
- Incidents where a plan appears to have been changed on the basis of some knowledge about the learner.
- Times when a new dialogue goal appears to have been introduced. In the subsequent interview the observer will attempt to ascertain from the teacher-composer the extent of plan revision.
- Changes in planning etc. that seem to have evolved over the 3 task-then-interview sessions (has the teacher made any reflective generalisations?).

5.2 Rationale for the questions to learner & teacher

I was on the look out for answers to the above research question (§1) and aspects of creative reflection (as defined above). I used questions 1-4 below as guides for post experimental cues: see §5 below. Question 5 tries to check how much the experimental setting affected the subject. Question 6 attempts to find out what values, motivations and beliefs etc. the learner/teacher holds about their own about learning/teaching (this question produced some useful answers in the second formative experiments and is hence being kept). At the end of the interview both students and teacher were asked for their attitudes regarding the use of Coleridge (question 7).

5.3 Questions for interview

1. Why did you make this particular (*response/teaching intervention*) ? (Based on my observations in the session.) What were you thinking when you made that particular (*response/teaching intervention*) ? What was your major concern?
2. How did you evaluate (*your/the student's*) response to the teaching intervention?
3. Do you think you would make the same (*response/teaching intervention*) again in the future? If you were to change some of your approach to (*learning/teaching*) would this have a positive or negative outcome?
4. Why did you decide to change your (*learning/teaching*) approach at this particular point? (Based on my observations in the session.)
5. In what way were your thoughts and (*learning/teaching*) methods different in this experiment from your thoughts and methods when you work with a (*teacher/student*) on your own?
6. Do you think your (*learning/teaching*) has changed in any way over the last year or two?
7. (For TA) Do you think the learning environment (Coleridge) has potential for use in teaching with other students?

Additional comments were recorded.

NB. It was originally intended to asked question 7 to the learners, however this was omitted with learner G, therefore the other student's responses have not been transcribed.

6. Post-experimental cue data gathering

Ericsson and Simon (1993) have proposed that there are various useful points at which retrospective verbal reports by subjects can be collected. Two of these points, or types as I will refer to them as, are summarised

below and then discussed in the context of my own formative experiment:

type 1. Immediately after a task the subject can be asked to report their 'thought episodes' by the interviewer, or in my experiment by the teacher. (Ericsson and Simon, 1993, p. xvi)

type 2. Post-experiment interview by cueing subjects (Ericsson and Simon, 1993, p. xlix)

Ericsson and Simon (1993) have suggested that following the completion of a task, cueing distinct 'thought episodes' is a useful way to approach to gathering type 1 retrospective verbal reports. This involves constraining the retrospective report by the subject to the recall of distinct thought episodes. In the study described in this report interventions were aimed at getting a learner to make predictions about a phrase or, following play-back of a phrase, evaluating their success at obtaining a match between prediction and outcome. This is type 1 data. The collection of type 1 retrospective verbal reports immediately after a task probably comes closest (of the two types) to reporting at least parts of the cognitive processes that occurred when a subject carried out a task. As long as this limitation is recognised then type 1 data can be seen as throwing light on some of the processes being reported.

Type 2 data collection should attempt to cue subjects with specific items from the experiment. Post-experimental questioning runs the danger of allowing the subject to report more than their past thoughts, they might resort to speculation and inferences. However, using cues taken from the experiment can diminish this problem. This approach in the study described in this report, involved the researcher and interviewer (me) taking detailed notes, as the session progressed of dialogue that seemed interesting (e.g. dialogue goals aimed at promoting the cognitive goals of reflection and monitoring). These notes were used as cues in the form of questions in the post-experimental interviews with the learners and the teacher.

7. Data gathered

Two video cameras were used: one was used to capture manipulations of the CBLE Coleridge, a second camera was used to observe the gestures of the human teacher and learner. A Dictaphone was used (which speeds up transcription) as third approach to recording sound.

8. Reliability of the data gathered

These comments were gathered in post-experimental interviews, where:

I = Interviewer

TA = Teaching Agent

LA = Learning Agent

TA after session 1:

I: Can I just say, did having me here and the cameras affect the way you taught? Did it influence you in any way?

TA: No I don't think so.

I: Your getting used to it.

TA: I'm getting used to it.

I: Good. That's a good start

TA after session 2:

I: Good, I think I found out quite a bit there, good. Lets, see. Let's ask you the question again, are you still feeling relaxed? In what way have your thoughts and methods different in this experiment? Are you still conscious of me being here, or?

TA: Oh no, no I'm not conscious of you being here. I'm more, I think I'm, to reiterate what I said in my last reply is that I'm become and more conscious of how such an activity reveals a student's own knowledge and skills.

LA1 after first session:

I: In what way were your thoughts and learning err, methods different in this experiment to the methods that you normally work with the teacher. Basically, I'm saying is 'has it affected you having cameras and me here?'

LA: Umm, yes, but, yes when I was first here I was conscious very much of the conversation that was going on. But then then no, and your affect, you being here had no affect whatsoever.

I: So, would it be fair to say that you loosened up after the first five minutes and just forgot about me.

LA: First two or three minutes. I never thought of you been there, it's was just conscious of, I was conscious of

the interaction between the two of us.

I: Great, and I really enjoyed listening to the session.

LA2 after second session:

I: The first one is: In what way were your thoughts and learning methods different in this experiment from your thoughts and methods when you work with a teacher on your own? So what I'm saying is: did having me here with these cameras affect the way you were with the teacher?

LA: Possibly, yeah, it's all sort of unfamiliar.

I: Yes, that's fair enough.

LA3 after third session:

I: Emm, this is a bit verbose this question I'll explain what it means after I've read it (both laugh). In what way were your thoughts and learning methods different in this experiment to your thoughts and methods when you work on your own with a teacher? Basically, with the cameras and me here, do you think it affected you very much? You can be honest, it's all right.

LA: Umm, no I don't think it did really.

I: You weren't too conscious of having me, of being observed?

LA: Not particularly, no because once you start you forget.

I: Yeah, because I'm behind you so, you got absorbed in what you were doing.

LA: If you were sat there I might have.

I: Yeah, it's a good point actually, with me being behind. OK, thanks.

LA4 after fourth session:

I: Just a few things to clear up. There's a very verbose question coming up now, we can have a laugh and then I'll say what it really means. It says: In what way were your thoughts and learning methods different in this experiment from your thoughts and methods when you work with a teacher on your own? So basically, me here with the cameras did it affect you were, interacted with Nigel?

LA: No.

I: You weren't too conscious 'cause I was here.

LA: No, I wasn't no. I mean, no, I can honestly say that actually.

I: Good, well I'm pleased to hear it.

LA: I'm not just saying it to make you feel better. If I was I'd tell you. But really don't think it made any difference.

I: So you just got engrossed in what you were doing.

LA: Yeah.

Conclusion

The teacher and three learners did not seem to feel that the observation setting had an undue influence on them. Learner 2 did feel that the observation setting had an undue influence on him. On the whole I conclude that the data gathered was a reliable record of teacher-learner interactions. The students normally get composition tuition on a one-to-one basis and the sessions observed will not have been too unusual for them, a conclusion that most of the above comments appear to support.

Appendix 2: Analysis approach

This appendix gives definitions of all the categories used in the analysis of interactions and an example analysis.

1. Pedagogical goals

1.1 Metacognitive goal

Definition metacognition: "refers to understanding of knowledge, an understanding that can be reflected in either effective use or overt description of the knowledge in question." (Brown, 1987, p. 65). Metacognition has been tightly constrained in this study to be creative reflection.

1.2 Mentoring goal

Definition: Mentoring intends to support the co-construction of knowledge and motivation to learn, to provide challenge through critical thinking and vision through creative thinking. The four lower-level goals are:

Definition Co-construction of knowledge: This refers to the participants' relationship or attitude to knowledge in that knowledge might be seen as an outside 'given' to be absorbed or transmitted, or on the other hand as co-constructed by teacher and learner, allowed to be queried, not 'true' for all time. The latter relationship to knowledge is taken in mentoring. [Mainly coded up using the communicative act categories.]

Definition Critical thinking: "... critical thinking is thinking that (1) facilitates judgement because it (2) relies on criteria, (3) is self-correcting, and (4) is sensitive to context." (Lipman, 1991, p. 116)

Definition Creative thinking: the ability of a learner to make accurate predictions and imagine opportunities in novel situations.

Definition Motivation: "Motivation in the sense of a willingness to pursue activities is ... an important factor in the TLP [Teaching and Learning Process], with two major subclasses: external organisational motivation (e.g. qualifications dependent on passing exams), and internal (e.g. intrinsic "interest")." (Draper, 1994, p. 11).

1.3 Task goals

Definition task goal: This is a description of what the teaching and learning interactions will aim to achieve, it provides a statement against which learning outcomes can be measured.

2. Interactive Goals

2.1 Mentoring sub-goals

Critical thinking sub-goals

Definition probing : This is the asking of questions of a higher-order thinking nature: "the question is a way of engaging the student in the directed practice dealing with a specific area of the problem at hand. The course of higher-order thinking may at appropriate moments be punctuated with pauses for such directed practice ... On the other hand, the focusing power of the question means that questions can be constructed that represent the points of view of major figures in the discipline. One might even employ the occasion to enlist hypothetical questions from figures in other disciplines." (Lipman, 1991, p. 224-225). Probing can be a focused used of observations of a student's phrase. An example of probing by the teacher from the study was: "... these [USES CURSOR 'I' BAR TO POINT TO 28 AND 24] surprises that you mentioned, very large leaps. Umm. Do they, segment the music? Or do you, do you see that jump there [POINTS WITH FINGER TO 28] triggering this little phrase here?"

Definition critical judgement: "Reaching a conclusion about a complex situation or phenomenon, generally without algorithmic deduction or calculation." (Moshman, 1995).

Definition critical give reasons: Any dialogue that involves the giving of criteria will be regarded as the critical giving of reasons: "... critical thinking is thinking that employs criteria and can be assessed by appeal to criteria ... Criteria are reasons; they are one kind of reason, a particularly reliable kind." (Lipman, 1991, p. 116-117).

Definition critical challenging: This is adversarial in that a proposition, for example, may not be accepted as true without further evidence being provided.

Definition critical clarification: Further elaboration of some point may be requested or given because (i) a previous attempt was unclear or (ii) a response was required.

Definition critical give evidence: Similar to a court of law, if some claim or judgement is made then evidence to back up a the claim or judgement may be requested. "Anyone claiming something to be a fact must be concerned about just how much evidence is needed in order to justify making that claim." (Lipman, 1991,

p. 168)

Co-construction of knowledge sub-goal

Definition collaboration listen to others: Where there is evidence in interactions that an agent has listened to another agent, e.g. where a collaborative response seems to have been adapted on the basis of interaction (verbal and/or musical and/or actions).

Creative thinking sub-goals

Definition creative imagine opportunity: Interaction (verbal and/or musical and/or actions) by either teacher or learner that concerns the mental imaging of a creative idea in a novel context. An example of 'imagining opportunity' would be a learner utterance like "I think I'd like to make it a bit more chromatic actually"

Definition creative make prediction: Dialogue by either (i) the teacher to elicit a prediction, or (ii) the learner that indicates that a prediction has been made about how an imagined novel opportunity will sound when played.

Definition creative accurate prediction: Dialogue by either teacher or learner that indicates that a successful prediction has been made about how an imagined novel opportunity will sound when played.

Motivation sub-goals

Definition motivation intrinsic: This usually involves the teaching agent giving an account of its approach to composition. Such a description would be intended to motivate the learner to develop their own approach to composition, perhaps on similar lines, but certainly one that motivates them to work.

Definition motivation extrinsic: Providing a concrete reason for pursuing a task. In normal music classroom interaction extrinsic motivation to do work for the portfolio is a strong factor in getting students to work on a task. In the study described below the students were sent a short letter by the teacher giving an account of the benefits that they might gain from participating in the study.

Definition motivation encouragement: Utterances like repeating another agent's utterance, or "Right" and "Umm" are viewed here as often having the intention of meaning "keep going" or giving generally positive feedback.

2.2 Metacognitive sub-goals

Definition target M or Ref: Some communicative acts may have the implicit intention of targeting the monitoring or reflection level of an agent (Cook, 1996). Usually it will involve the teacher's attempts to elicit verbal self-explanations (Chi, Bassok et al., 1989) from the learner about their own attempts at creative reflection. This goal is intended to help learners integrate new knowledge with existing knowledge. If the goal is accepted the agent can use it to monitor their progress, to imagine opportunities, etc. It is typically the asking of open-ended questions.

Definition monitoring evaluate: Dialogue that involves some evaluative comment about the match between a prediction and an outcome is indicative of monitoring.

Definition monitoring diagnose: A second type of monitoring will involve an attempt to diagnose why something did or did not work.

Definition reflect predict: Creative reflection is defined as the ability to make accurate predictions. 'Reflect predict' is a pause where the context shows that the learner reflects about a prediction before actually using a mentoring goal to make a prediction.

Definition reflect imagine opportunity: Creative reflection is also the ability to imagine opportunities in novel situations. This goal is indicated by pauses, or utterances like 'umm', where the learner reflects about an opportunity before actually using an mentoring goal to state what that opportunity is.

3. Communicative Acts

Typically in speech act theory (Searle, 1969) we have assertions, questions and requests, which do not cover all written or musical acts. By drawing on work by Baker (1994) and Fox (1993) this section presents some communicative acts that have extended these basic "speech acts" to include the notions of offer, accept and reject. These three communicative acts are supplemented with other acts.

Definition Communicative Acts (CA): are at the leaf level of the Knowledge Mentoring dialogue analysis framework, and can be used to realise, with different contents, many of the upper level interactive and pedagogical goals.

Definition assertion: Communicates that the speaker believes/accepts the content to be a fact.

Definition assertion confirmation: A earlier assertion by another speaker has been accepted by the current speaker.

Definition- question: A wh-question, i.e. communicates that speaker wants hearer to provide certain information, more or less specific, and that speaker believes hearer can provide that information.

Definition request: Like questions, except concerned with action, getting other to do something, with exception

of information providing which would make it a question: speaker wants hearer to perform action A, speaker believes hearer can perform action A. Or announcing that something needs to be done and then doing it.

Definition offer & accept: A suggestion of how to proceed, 'who should do what next'. If the teachers accepts the learner's offer, or if the student accepts the teacher's, then the teacher and learner set about getting 'to work'.

If an offer is spread over a number of turns then code as 'offer continue'.

If confirming a previously accepted offer code as 'accept confirm'.

Definition reject: An offer is not taken up, or an assertion is not accepted.

4. Relations between acts

The following two categories are not speech acts, they refer rather to relations between acts.

Definition transform: Where an offer is changed in some way based on negotiation but remains similar to the original offer. Here, "transform" means a communicative act has been made, e.g. an offer, and it (transform) bears a special relation to a previous one of the other speaker to the extent that the contents of the current offer "transforms" that of the previous.

Definition complete: This is where, for example, the teacher or student leaves a sufficiently long gap ($\geq .7$ seconds) for the other to add the correction or continuation to the end of a sentence. Here, "complete" means a communicative act has been made, e.g. an assertion, and it bears a special relation to a previous one of the other speaker to the extent that the content of the current assertion "completes" that of the previous act (e.g. an offer).

Three possible collaboration strategies in this framework are (i) an offer is accepted and agents get to work, or (ii) the offer is 'transformed' (iii) the offer leaves sufficient space for the other agent to 'complete' or contribute.

5. Other categories

Definition pauses: pauses by LA that are considered to be indicative of some form of 'reflection' in a broader sense (i.e. outside the scope of creative reflection but related to critical goals or questioning acts). Pauses of 9 tenths of a second upwards were coded. (Note that the score will excludes 'possibly reflecting LA', 'reflect predict', 'reflect imagine opportunity', and pauses related to 'complete'.)

Definition action: Some form of action (e.g. music or manipulation of the computer). Actions will be related to goals and acts.

Definition other: Utterances that did not easily fit into one of the Knowledge Mentoring framework categories defined above.

Definition possibly reflecting LA: this is where the context strongly suggests that pauses are indicative of cognitive activity related to creative reflection (usually monitoring activity). Pauses of 9 tenths of a second upwards were coded. (Note that the score will excludes 'pauses', 'reflect predict', 'reflect imagine opportunity', and pauses related to 'complete'.)

Definition dialogue management: utterances related to organising who talks next, or to keep the current speaker talking or to open or end a session.

Appendix 3: Sample transcription from corpus (session 1)

(The full corpus can be made available by e-mailing the author: j.n.cook@open.ac.uk)

TA: Umm, lets err, shall we have another go?

LA: Yeah.

TA: And see if perhaps // make it slightly more // whoops.

TA: [FROM END OF LIST USES DELETE KEY TO START DELETING LIST SO THAT ONLY 0 -5 REMAIN]

LA: [POINTS AT THE LIST] We'll keep=

TA: Oh you wanna keep that

=[

LA: I was gonna keep, that as a 7.

TA: [TYPES AT END OF LIST: 7] OK.

LA: Yeah.

TA: And then going back to nought, again? // Or you gonna

LA: Err

LA: It went, err yes, go back to 0 [TYPES AT END OF LIST: 0 SPACE] And then=

TA: =do you think it could be longer this time?

LA: *Yeah*, I think it could be. (9.7) I think I'd like to make it a bit more [TYPES AT END OF LIST: 28 SPACE] chromatic actually.

TA: You'd like to make it a bit more chromatic.

LA: Yes.

TA: This is going to 28, that's an enormous jump.

LA: Yeah, going right, right // up to the top.

TA: OK?

LA: Yeah. Umm.

TA: So that's more than the two octaves isn't it?

LA: Yeah, and that'll go right up to an A.

TA: Yeah.

LA: Yeah, that's fine.

TA: This is, we could only really probably play this on, we're starting at middle C [POINTS AT MIDDLE C ON THE KEYBOARD].

LA: Uh huh.

TA: With this, I mean, imagine playing it on a violin.

LA: Of yeah, that'd be difficult.

TA: So this is, were you thinking of this as a sort of keyboard piece?=
LA: =Yeah, that's right.=

TA: =It's a keyboard study.=

LA: =Definitely, yes.=

TA: =For one hand.

LA: Yeah. [ADDS AT THE END OF THE LIST: 2 2] No that goes up two again doesn't it. Is that right?

TA: No, no, that. Two, // it will always be, if you think of nought is C.

TA: [DELETES '2 2' FROM END OF LIST]

LA: Oh, so it'll always, so twos going to there // yeah, right.

TA: Yes, it's going to that.

LA: [THE LIST IS: 0 -5 7 0 28, LA ADDS TO THE END OF LIST: 2 2 1]

TA: Certainly got a chromatic section there.

LA: Yeah. [ADDS TO THE END OF LIST: 24]

TA: Then another large leap.

LA: Yeah.

TA: But that is a. Yes.

LA: [ADDS TO END LIST: -5]

TA: Another even larger leap downwards.

LA: Uh huh. [THE LIST IS: 0 -5 7 0 28 2 2 1 24 -5, LA ADDS TO THE END OF LIST: -4 -3 -2]

TA: Another chromatic figure.

LA: [THE LIST IS: 0 -5 7 0 28 2 2 1 24 -5 -4 -3 -2, LA ADDS TO THE END OF LIST: 12 0]

TA: Right , // OK.

LA: (I think that's OK)

TA: Compile button // I'm just going to, // I'm just going to name this differently. We'll do this as transpose 3,

because this is our third attempt=

LA: OK.

TA: [SCROLLS DOWN TO END OF CODE AND CHANGES OUTPUT FILE NAME FROM TRANSPOSE-1 TO TRANSPOSE-3]

LA: =Yeah, OK.

TA: [SAYS SOMETHING INAUDIBLE, CLICKS ON COMPILE BUTTON] Press the compile button. It's nice to be able to keep all the different versions.

LA: OK. So have you written all of this then?

TA: Yeah, it's just a little program, that generates this material. Right, lets see what happens. [PLAYS NEW PHRASE, WHICH LASTS 9.6 SECONDS].=

TA: Was that getting close to what you wanted?

=[

LA: [STARTS TO SPEAK]

LA: Yes, got clos::er. I don't think I'm going to have the nought on the end.

TA: [SCROLLS UP TO DATA ENTRY POINT AND POSITIONS CURSOR AT THE END OF THE LIST]

TA: You don't think I'm going to have the nought // on the end.

LA: No.

LA: I don't think like the nought on the end=

TA: =OK. [DELETES 0 FROM END OF LIST, WINDOW NOW LOOKS LIKE THE REPLICA BELOW] we'll take that out. Umm, do you see a structure developing in that?

The screenshot shows a software interface with a menu bar (File, Edit, Eval, Windows, Folders) and a toolbar. The main window is titled "Student G #2 {...0M Lessons:students G-J:}" and contains a code editor with the following text:

```

;;; transposition
; use this device to generate a sequence of your chosen
; pattern occurring at different pitch positions. By
; creating a list of transposition numbers in relation
; to a base position (value 0) a musical phrase or section
; may be produced

;; basic material
(make material '(a b g h))
(make note-length '(1/16))
(make dynamics '(96 64 72 84))
(make tonality (activate-tonality (chromatic c 5)))
(def-tempo 96)

; Here's an example. Compile and Play MIDI.
(make my-study-with
  '(0 -5 7 0 28 2 2 1 24 -5 -4 -3 -2 12))

; now replace the values in the example with your own

```

Below the code editor is a MIDI player window titled "Transpose-3". It has a table for time and length settings:

Hour	Min	Sec	Bar	Beat	Tempo	Time	Length
0	0	0	0	0	120	4/4	4:4

Below the table are playback controls: Stop, Play, and a MIDI keyboard icon. There are also checkboxes for "Loop" and "Chase", and buttons for "Jump", "Clear", and "Set". The "Begin" and "End" fields are set to 1 1 1 and 5 1 1 respectively.

At the bottom of the window, there is a message: "Save midifile ccl/output:Transpose-3 (piano1) ok" and a prompt "1 >".

LA: (.9) Umm (.9) yes=

TA: =in the way you've used the (1.1)

LA: There is a structure, there's an idea there in mind=

TA: =Yeah, and what, how would you describe that? (.9)

LA: Well (2.2) describe it as, [POINTS WITH FINGER TO FRONT OF LIST] starting at C, // delving into Ab here [POINTS WITH FINGER TO -5 7], reminding ourselves of C [POINTS WITH FINGER TO SECOND 0 IN LIST] and then by the process of these [POINTS WITH FINGER TO 2 2] looking as if we're returning to C, which we do [POINTS WITH FINGER TO 24] but we don't actually return there. And then suddenly we're back in Ab again but are we going to C? And we do reach it then [POINTS WITH FINGER TO END OF LIST] but then I don't, I don't think I would finish it with the C. I wouldn't finish it with a nought because I thought it was a bit boring (hh). =

TA: Yeah.

TA: =What, what do you see, what do you see the function // of these very large leaps as?

TA: [USES THE 'I' BAR TO POINT TO 28 AND 24]

LA: Umm, variation. As in (.9) err (1.7) surprise=

TA: Yeah, it is a surprise. It's not what you would expect.

=[

LA: [SAYS SOMETHING INAUDIBLE]

LA: No.

TA: Lets, lets do the umm, shall we just hear that as you.

LA: Right, I wouldn't, I would, I would [POINTS WITH FINGER TO END OF LIST] put a 2 on // the end there.

TA: You would put a 2 [CLICKS AT END OF LIST AND DELETES THE 12] on the end there.

LA: Yeah. Well, sorry a 12 and // then a 2.

TA: 12 and then a 2 [TYPES AT END OF LIST: 12 2]

LA: Yeah.

TA: So it's ending there.

LA: Because then I, I don't, I don't want to end on the nought, and it sort of // I keep C. (hh).

TA: Right.

TA: Yeah, so it's keeping suspense, it isn't resolving.

LA: Yeah, keeps it.