Hyperscore; A Case Study in Computer Mediated Music Composition

Kevin Jennings

Abstract.

This paper is an in-depth case study of a child engaged in music composition using novel music composition software. It examines the child's and the teacher's behaviour, process and strategies while using the software. It seeks to demonstrate how the software enables the child to engage in certain musical processes commonly associated with adult or professional composers and notes which features of the interface seem particularly useful in this regard. It outlines certain teaching strategies which seem to be effective in a technology mediated music learning context. Finally, it briefly points to the effectiveness of digital video technology in tandem with graphical computer interfaces as a medium for the examination of childrens creative process in music composition.

Introduction

During the act of music composition, many kinds of learning may occur. Students may learn directly about the important musical concepts needed for successful composition. They may also learn something about the compositional process itself, the kinds of strategies and working methods most effective in realizing their musical vision. On another level, they may engage with fundamental musical principles and rudiments.

In traditional teaching and learning settings however, there are factors which may make it difficult for children to engage with any of these elements through composition. There are difficulties associated with instrumental competence, necessary both for the generation of new ideas and the playback, examination and testing of work in progress. There is also the problem of notation. Music notation systems serve as media for the storing and transmission of musical output. In the context of composition, a notation system also acts as an '*object to think with'* (Papert, 1980), a vehicle for exploring the material in hand, examining its attributes with a view to transforming or extending it. Children with little instrumental training or who are not conversant with standard music

notation can find it very difficult to engage in this type of reflective exploration inherent in music composition.

Technology, specifically computer-based graphical composing software may offer a possible solution to these problems. It can provide a combination of an intuitive, editable symbolic representation in tandem with automated playback that may enable even novice musicians to engage in compositional exploration. The Hyperscore software used in this study was specifically designed to address these issues.

The current study is informed by the broader question of how to best use technology to enable children to engage in music composition. Specifically, through a close examination of a single case of a child composing with this specially designed piece of graphical computer software, it seeks to identify what sorts of learning can occur as children compose using technology. It examines how the technology facilitates and enables the child to engage with fundamental musical principles and processes in a manner similar to trained adult composers. It also examines the role of the teacher and attempts to identify teaching strategies that seem appropriate and effective in a technology-mediated context.

Composing

Learning to compose involves engagement with both the musical principles which inform the compositional act and with the underlying process through which the work evolves. Eminent American composer Roger Sessions (Sessions, 1970) describes composing in terms of a number of broad general principles; association through repetition or variation, contrast, cumulative movement/continuity, balance/proportion and articulation. Arnold Schoenberg (Schoenberg, 1975), describing his concerns as a teacher of composition emphasized;

> "*clear and distinctly phrased formulations, logical continuations, characteristic contrasts and constructions, accommodated and changed in response to various purposes"*

Both composers emphasise fundamental ideas of movement and rest, balance between small-scale ideas and larger forms, unity and variety, development, transformation and change.

Peter Webster (Webster, 1994) characterizes composition in terms of the creative process. He divides this process into a number of distinct stages. The preparation stage is characterized by divergent thought processes and the generation of ideas. A period of reflection on these ideas (incubation) is followed by a period of illumination and verification where earlier ideas are worked out in a more convergent, linear manner. This is broadly in agreement with composers' reflections on their own working process. Many composers report progressing through various stages as they work, often beginning with a 'germinal' idea and moving through stages involving sketching ideas, making drafts, elaboration and refinement before the final draft (Bennet, 1976).

Children Composing With Technology

A number of studies have investigated children composing using computers and associated technologies as a facilitating medium. Hickey (Hickey,1997a, 1997b, 2001) has carried out studies investigating aspects of childrens creative process while composing with computers. The focus here is on analyzing creativity primarily on the basis of compositional product. Folkestad (Folkestad1997, 1998) defines a topology of compositional strategies used by children when composing at the computer. Childrens working practices are characterized as 'horizontal' or 'vertical' based on computer files saved at intervals as they work along with interviews of the participating children. Wilson and Wales (Wilson & Wales, 1995) assessed childrens computer based compositions for rhythmic and melodic coherence and correlated these with qualitative observation of childrens working practices. Younker (Younker, 2000) analysed childrens thought

processes and strategies based on verbal reports and interviews before, during and after the composition task, describing behaviours such as exploring, recording, evaluating, practicing and editing.

These studies have in common the manner in which technology was used. In each case, a keyboard was connected to a computer running standard sequencer or notation software. Composition was carried out at the keyboard and recorded using the sequencer, either periodically or upon completion of the piece. Where a representational system is used, it is standard staff notation. The software use in the current study has been designed for screen-based work so that no instrumental skill is required, while the representational system is not based on standard music notation..

Description of The Software

Hyperscore (Farbood 2001, Farbood, Pazstor & Jennings, 2004) is a novel piece of software designed by Mary Farbood and Egon Pazstor at the MIT Media lab, Cambridge, Massachusetts, with some design input from the author, specifically with a view to facilitating composition activities for beginners. Further information may be found at the Toy Symphony website[i]. In order to enable the reader to understand the operation of the software, a brief description will be given. The reader, however, is encouraged to download and explore the software to gain a fuller appreciation of its functionality. The Hyperscore screen is shown in figure 1.

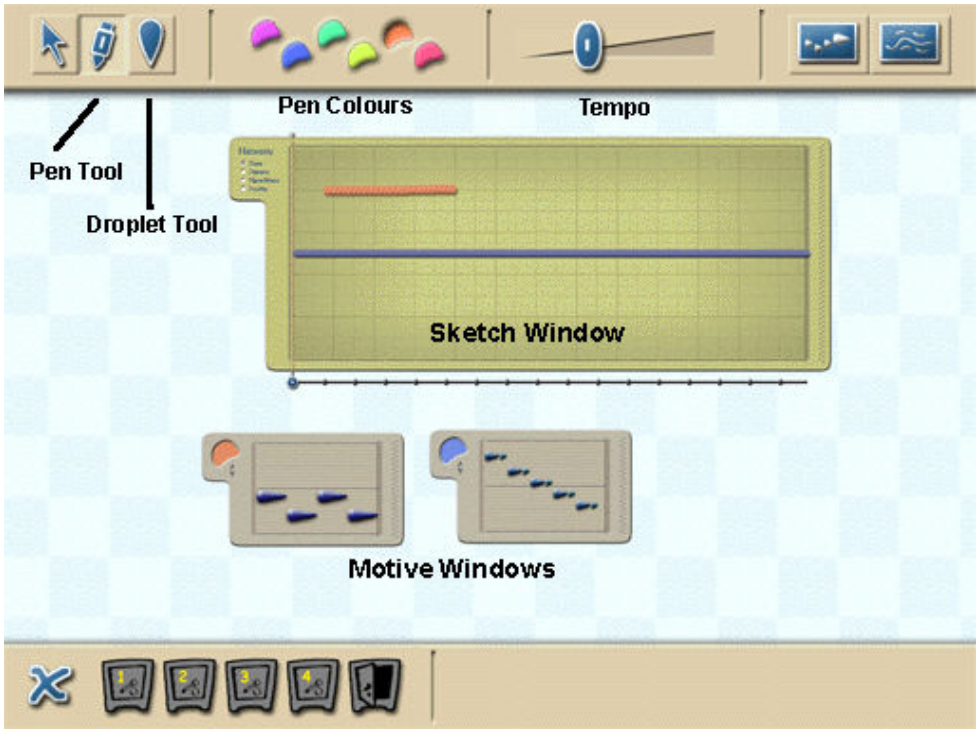

Figure 1. Hyperscore

The Hyperscore interface consists of a 'zoomable' working area which may contain two types of 'window', which will be referred to as the 'motive' window and the 'sketch' window. Users may place as many motive and/or sketch windows in the working area as required. They may then hear the results of their work via MIDI playback.

Composition activities in the Hyperscore environment proceed on the premise that the piece of music will be based on a number of short musical ideas or motives. Each motive is made by placing notes in the motive window, on a timeline from left to right with pitch top to bottom. Motives, which are colour coded, may then be placed in the main sketch window by using the mouse to 'draw' them in with the appropriate colour pen. Motives will repeat for the duration of the stroke. Motives may be layered to create multi-part textures. Users may draw contoured lines to create melodic shape. The software will then interpret these strokes according to a 'best-fit' between the content of the particular motive window and the overarching shape of the stroke. A variety of automated and semi-automated harmonization options are available, controlled by reshaping the central horizontal line in the sketch window.

Methodology

During the study from which this case is selected, ten Irish primary school children aged 9-11 used the Hyperscore software for between eight and ten fifty-minute sessions over the course of a five week period. In this time each student composed one extended piece of music (between two and four minutes) using the software.

The research methodology applied was primarily based on an action-research model as described by Bresler (1996). The point of the study was not to examine childrens work in a detached way, but to investigate the value of the software in a real teaching and learning situation, including an assessment of its effect on teacher approach and strategy. The author acted as a teacher throughout, making interventions where appropriate, questioning children as they worked, offering suggestions, feedback and support.

Data were collected using digital video cameras trained on the computer screen as the children worked, providing a complete record of everything they did. All learner-teacher conversations and interactions were recorded for later analysis. Childrens pieces were saved a number of times in each session and interviews with each child were recorded both during and at the end of the process.

In any investigation of children composing, there are limits to what may be inferred about their learning from examination of compositional products only. Snapshots of their work at various stages in the process may miss important or revealing events, while there are also dangers in relying on childrens own descriptions of their processes elicited through interviews or conversations. In order to understand these processes, it is necessary to observe closely, continuously and at various levels of detail. The degree of separation required by this type of observation poses clear problems for the participant researcher.

Digital video may offer a solution to this problem, especially when used in tandem with an easily observed graphical working environment. This paper offers an examination of

both technology mediated learning and technology-mediated research, investigating not only the learning and teaching but also the effectiveness of digital video technology as a research tool when used in conjunction with computer graphical interfaces.

The Case Study.

At the time of the study, Kevin was ten years old (in 4th class in the Irish Primary School system). He had no prior formal training in music and very little prior musical experience at all beyond informal song singing in class. He had never studied a musical instrument, did not read standard music notation and was not explicitly familiar with other representational forms (tonic sol-fa etc). He was in the upper quadrant of his cohort in terms of overall academic achievement. He worked with the software for eight sessions of 45-60 minutes duration over a period of about five weeks.

While it would be impractical to give a complete description of everything that happened during these sessions, selected interactions illustrating particular points are described below. In order for the reader to fully appreciate the musical examples discussed, these are available in MIDI format at the author's webpage, along with selected video examples of Kevin's work in progress.[ii]

In the first session Kevin is introduced to the software. He is told that he will be using the software to compose a piece of music, and is introduced to the idea of 'motivic' composition as embodied in the software. He is given an introductory task which is to;

"*make four musical motives that you like and that are different from each other"*

Kevin works at this task unaided for approximately twenty-five minutes. During this time he produces four musical motives, a typical example which is shown in figure 2.

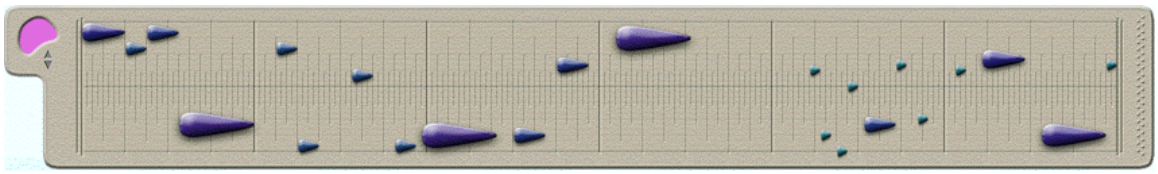

Figure 2. Motive Example 1.

Kevin's working process seems almost completely random. The motive itself seems to have no clear melodic or rhythmic structure. While making the motive, Kevin listens once to his work early on in the process but then does not listen again.

The teacher questions Kevin as to his motivation for particular actions (T indicates the teacher, K indicates Kevin, the student)

> T - *OK (points to a specific note) so why did you put that note there? Because it looked good or because you thought it looked right, or because you thought it might sound right, or….or for some other reason?*
> *K - .....basically I was fiddling around with it to see what it would sound like…..'*
>
> At this stage in the process, Kevin is interacting with the interface, rather then the musical material. He has not yet defined the task as a musical one. After further discussion on this topic, Kevin says;
>
> *K - ' Because if you don't know what it sounds like, then you don't know whether it'd be good or not, so……so, you need to test it first, so as you know what it sounds like, build it up, you know…..'*

The teacher has noted the apparent randomness of Kevin's working process and made an intervention designed to encourage Kevin to move beyond the superficial exploration of the interface and reframe the task in a musical context. This interface facilitates the teacher in making this intervention, allowing him to point to a particular note and ask a specific question, causing Kevin to refocus.

In the second session Kevin is asked to make just two musical motives that which would 'go together'. The 'go together' concept is not explicitly defined. Kevin's working strategy in the second session is markedly different from that in the first. As he places notes in the motive windows, he continually plays back and listens to his work. His exploration is fluid and purposeful, facilitated by the immediacy of the aural feedback he receives. The motives he produces are fundamentally different in character from those he made in the first session (figure 3). They are both based on a single melodic interval and have a definite rhythmic structure, indicating Kevin's engagement with the musical aspects of the task and interaction with fundamentals of musical structure.

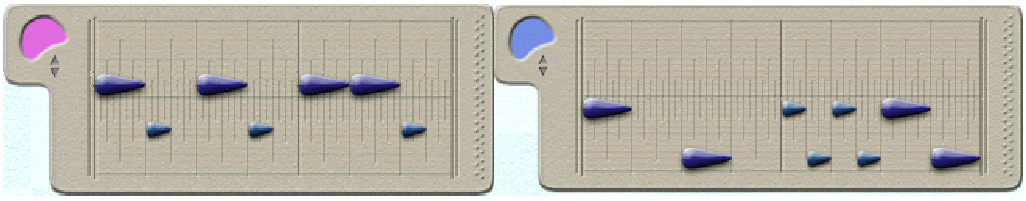

Figure 3 – Two new motives.

While working on the second motive, Kevin stops half way through, seeming to have run out of ideas. The teacher makes a suggestion.

> *T - Ok, so why don't you try this for a strategy? Play the motif, close your eyes, and listen to that go bom bom bom bom….and imagine what note comes into your head to fit after that, then see if you can find the note*
> *K - (plays motive and listens) Oh, Oh ….I think I…*
> *T - did you have any imagination? Was it a high note or a low note?*
> *K ……two high notes and a low note (pointing at screen)*

Kevin sings his idea and goes on to construct it. In this interaction, the teacher is again concerned with Kevin's process. He adopts the strategy of having Kevin listen and try to imagine what might come next. Kevin then uses the interface to work out his idea. They then 'test' how well the two motives go together by drawing them into the sketch window. In playback, as the two motives repeat they get progressively out of sync, owing

to the fact they are different lengths. At first Kevin does not notice, but on being encouraged to clap the rhythm of each motive and listen several times he notices and clearly identifies the problem. During the ensuing conversation he engages with the idea of ‘goes together” as it relates to motivic length and discovers the concept of a ‘silent note’ or ‘rest’, which he uses to extend the shorter motive so that the lengths become equal. In this instance, Kevin discovers a fundamental musical concept in the context of trying to solve a real problem. Again, the intuitive nature of the representation and its ease of manipulation again enables him to construct this new understanding.

By the third session Kevin has moved on from these more constrained tasks to confront the bigger issue of how to make a piece of music. He has made several motives and tried them in the sketch window in various combinations. He decides he needs a new motive, to complement those he already has. The teacher suggests he think about the ideas of repetition and variation. By making a short motif himself, he demonstrates how to use the copy-and-paste functionality to easily duplicate short melodic fragments and how to vary these by moving smaller groups within the motive. Kevin applies this strategy to his own musical material in building his new motif, highlighting groups of various sizes, copying, pasting and shifting them at will. Some of the various stages through which he goes are shown in figure 4. The most interesting aspect of the process is the manner in which the level of detail to which Kevin is attending changes continually as he works, from single notes to two note groups to more aggregated units.

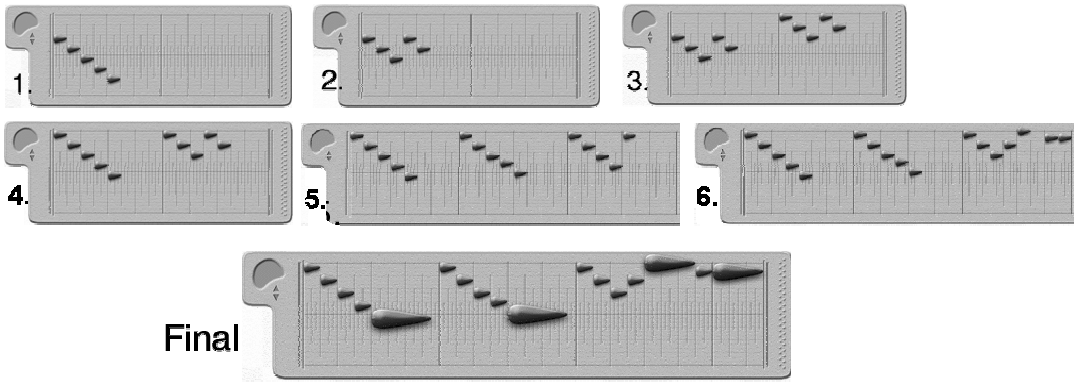

Figure 4. The motive building process.

In speaking of composition, Roger Sessions (Sessions, 1970) describes the process as one in which an initial idea presents itself, the composer works with this idea until its implications make themselves known. As the process continues, the particular outcome becomes more and more inevitable.

> *"His choices are made within a specific framework, which, as it grows, exerts an ever greater influence on what is to come"*

Kevin clearly has undergone some sort of analogous process. Each step has suggested something about what might come next, gradually moving towards what can ultimately be the only resolution.

In Kevin's penultimate version of the motive, all the notes are short, with gaps between the sections. The teacher asks him to sing the motive. When he does so, he sings longer notes in these gaps. He immediately notices this himself and moves to extend the notes in question. In this instance, there is an issue of perception. Kevin has a clearly formed idea of what the motive should sound like. He does not notice that there are small differences between his internal representation and what the computer is playing back. The teachers function here is simply to direct his attention to the disjunction. Kevin then perceives the difference and rectifies the situation.

Kevin then works primarily in the sketch window for a number of sessions. He completes his piece in definite stages working from left to right (figure 5).

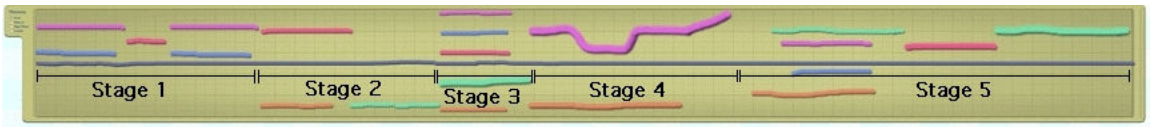

Figure 5. Kevin's completed piece.

In moving from one stage to another he seems concerned with contrast between the sections. He achieves this contrast through manipulation of musical elements including texture, contour and alignment of entries. At all stages, the teacher engages Kevin in conversation about his work in order to ensure that his engagement is with the musical rather then visual aspects.

Each new stage seems to involve exploration of a new idea. For example, stages 1 and 2 are texturally thin, In stage 3, Kevin makes a deliberate decision to use all his motivic material in parallel. As he does this, he says;

K – *'I don't think that people will be expecting it in the audience.'*

He clearly perceives the sudden thickening in texture as an expressive gesture which is designed to catch the audience off guard. The teacher suggests that Kevin might think of various ways that the effect of this surprise might be heightened.

The teacher then askes Kevin if he wants any one voice to stand out so that the audience would notice this, and if so how might he achieve this. After some discussion, Kevin suggests,

K – 'You could make it sound a bit different.'

Further discussion leads to the idea of changing the timbre of a given voice as a way of making it ‘stand out’. Kevin’s reference to an audience indicates that he sees himself as engaged in a meaningful compositional task. The teacher encourages this shift in perspective as a way of having Kevin engage with expressive gesture.

Stages four and five respectively see Kevin experiment with contoured strokes and overlapping entries, while the second part of section five is constructed by copy-and-paste of material from the very beginning of the piece, indicating some awareness of the need for balance and unity across the piece.

Discussion and Conclusions.

Although musically untrained, Kevin is possessed of a keen ear and demonstrates on many occasions the ability to imagine and externalise musical sounds accurately in pitch and rhythm. In the course of making his piece he has engaged with musical rudiments such as note value, pulse, rhythm and rhythmic heirarchies, pitch, melody and texture . He has assembled motivic units into a meaningful structural whole, with definite sections. He has made deliberate use of techniques such as repetition and variation of both melodic units and musical textures. He has manipulated timbre and dynamics to a definite expressive purpose and engaged with the sort of fundamental musical concepts of change, movement, contrast, function and balance outlined by both Sessions (1970) and Schoenberg (1975). He has also begun to aquire strategies for dealing with specific problems. As Kevin does not play an instrument or read staff notation, it is almost impossible to conceive of him making a piece of this complexity or engaging with these musical concepts without being facilitated by this or similar software. The software has been a vehicle for him to explore musical ideas and concepts which might otherwise have been beyond his reach.

Kevin engages in a compositional process analogous to that described by both Sessions (1970), Bennet(1976) and Webster(1994). There seems to be an additional initial stage in his process however, which is a function of working in a technology mediated

environment. Before engaging in the musical aspect of the task, Kevin undergoes a period of exploration of the interface itself, which might be termed 'bricolage', (Turkle, 1995). Having established the parameters of the interface, this element of playful experimentation continues to inform his work as he moves on to the compositional task itself.

Kevin's work is supported by particular features of the software. It presents him with a clear, intuitive, predictable representation with playback capability. The simplicity and directness of the 'drawing' metaphor enables an ease of extension and transformation of the material. The inherent motivic composition paradigm, while an approximation of the way in which adult composers work, has the advantage of modularizing the task. It takes the larger and poorly defined task of making a piece of music and breaks it into manageable chunks, i.e. '*make little bits of music, then make a bigger piece out of these*'. It also enables the student to choose the size of their 'working-unit' at any given time, and to 'zoom' the level of detail to which he attends from the individual note right out to an overview of the whole piece. In so doing it makes it possible for him to engage with higher level ideas such as structure, form, balance and change.

When working on smaller units, Kevin inclines towards conventional means of expression. His motives are dominated by regular intervallic progressions commonly based on min 3rd, 5th and 6th. While diatonic scale patterns are not explicitly used, there is a definite tonal sense. He demonstrates a clear preference for hierarchical rhythmic relationships, regular note placement with respect to the underlying pulse and motives based on one, two or four measure units. This contrasts with his work in the sketch window. When working on larger scale aspects of his piece he experiments little with the intervals between strokes and seems unconcerned by questions of conventional diatonic harmony. The piece does not begin and end in the same key. In so far as there is any strong sense of key from moment to moment, it is simply a function of the tonal implication of whichever motive is most prominent at the time. Working on this larger level, his main concern is with aspects of rhythm and function. He is careful to ensure that beginnings of strokes are aligned, that strokes contain whole numbers of motive

repeats and that strokes are deployed in a way that reflects the function of the given motive as melody, accompaniment or bass part.

The implication here may be that, when working on the smaller scale at any rate, Kevin is giving expression to his encultured or innate musical perceptions. However when he moves into the larger space he is selective in what he attends to. Despite living in a culture which values music based almost exclusively on tonal harmony, Kevin largely ignores this aspect in his work. This "selective attention" may well be a function of the structure of the interface itself. The small-scale motive windows encourage attention to certain attributes of the materials at hand. When he moves into the larger space he carries with him these same concerns. The sketch window does not make harmonic issues manifest in a way which impinges on Kevin's consciousness to the extent that he engages with them. Furthermore, Kevin makes no overt reference to any popular, folk, classical or indeed any specific musical genre as he works, but rather works with the constraints and implications of the interface as he finds them. This points very clearly to the notion that what we think about and how we think about it are, to some extent at least, a function of the tools we are using. There are clear implications here both for the design of music learning software and also for teachers, who may need to be very aware of the bias or emphasis inherent in any software they are using.

In helping Kevin to approach the composition task, the teacher engages in certain types of intervention and adopts a variety of strategies. Interventions include those concerned with task framing, helping the student to develop appropriate criteria for judging work, ensuring students perception is aligned with the actual output, engagement with musical rudiments and encouraging the student to adopt a broader perspective which might include performers and an audience. Strategies adopted include use of the interface to facilitate pointed questioning, use of examples, modeling strategies and behaviours and analysis of Kevin's musical material. There is also some emphasis on moving into the kinaesthetic domain through clapping and singing. Throughout the sessions, the ease and speed with which material may be manipulated facilitates a free-flowing dialogue between student and teacher that might be difficult to achieve otherwise.

The study from which this case is taken was conducted in a situation involving two students at a time, working in the same room with the teacher dividing his attention between both. There is no reason however why the software might not be used in classroom situations involving larger numbers of children (In fact, the author has supervised workshops involving as many as twenty children at a time). For practical purposes, multiple computers (preferably one per student) and headphones are required. The real challenge for the teacher though, is how best to divide time and attention so as to accommodate the needs of larger numbers of students. While this may seem a daunting prospect, in practice children using the software very quickly form their own agenda and are capable of working unsupervised for relatively long periods of time, allowing teachers to circulate freely, offering advice and support as required. As the children are engaged in composing their own unique piece, there is less pressure on teachers to 'know all the answers", enabling music teachers who may not be specialist composers to engage in dialogue with students as equals. For teachers who are willing to relinquish traditional roles, this may be the most rewarding aspect of working in computer-mediated environments.

Finally, the combination of both graphical interface and digital video enable the study of childrens compositional process in a holistic way. The screen-based graphical software environment provides a mechanism whereby children can externalise their understandings in a way which may be easily observed and also act as a vehicle for student-teacher conversations, leading to greater insight into internal processes. Digital video allows a blow-by-blow, minute-by-minute description of the students interaction with the interface itself, the musical material and the teacher, enabling teachers and researchers a unique window to observe the teaching and learning situation in a realistic and meaningful way. It may be used to record learner interactions while the teacher is not present, allowing students to develop a sense of autonomy as they work. It also frees up the participant-researcher to respond intuitively to the demands of the situation while recording events for later detailed analysis.

References.

Bennet, S. (1976) The process of musical creation: Conversations with eight composers. Journal of Research in Music Education, 24, 2-13

Bresler, L. (1996) Basic and applied qualitative research in music education. Research Studies in Music Education, 6, June, 5-17.

Turkle, S. (1995) Life on the Screen: Identity in the Age of the Internet. Simon and Schuster, New York,

Papert, S. (1980) Mindstorms: Children, Computers and Powerful Ideas. Brighton, The Harvester Press.

Schoenberg, A. (1970) Style and Idea. Leonard Stein (Ed), London, Faber and Faber.

Sessions, R. (1970) Questions About Music. New York: W.W. Norton and Co.

Webster, P. (1994) Time, technology and the creative process. Arts Education Policy Review, 96,1, 32-36.

Hickey, M. (1997a) Understanding childrens musical creative thinking processes through the qualitative analysis of their MIDI data. Bulletin of the Council for Research in Music Education, 131, 29-30.

Hickey, M. (1997b) The computer as a tool in creative music making. Research Studies in Music Education, 8, 56-69.

Hickey, M. (2001) An application of Amabile's consensual assessment technique for rating the creativity of childrens musical compositions. Journal of Research in Music Education, 49, 3, 234-244.

Folkestad, G. (1997) Young peoples music in the digital age: A study of computer-based creative music making. Research Studies in Music Education, 9, 1-11.

Folkestad, G. (1998) Compositional strategies in computer-based music making. British Journal of Music Education, 15, 1, 83-97.

Wilson, S & Wales, R.(1995) An exploration of childrens musical compositions. Journal of Research in Music Education, 43, 2, 94-111.

Younker, B. (2000) Thought processes and strategies of students engaged in music composition. Research Studies in Music Education, 14, 24-39.

Farbood, M. (2001) Hyperscore: A new approach to interactive computer-generated music. Unpublished Masters dissertation, MIT, Cambridge, Massachussetts.

Farbood, M., Pazstor, E., Jennings, K., (2004) Hyperscore, A graphical approach to composing music. IEEE Computer Graphics and Applications, Special Issue on Emerging Technologies, January-March 2004, 50-54.

Footnotes.

---

[i] http://www.toysymphony.net
[ii] http://www.cs.tcd.ie/crite/projects/creative-music/publications/IFIP.html