

## **Modelling, meaning through software design.**

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This paper builds upon an approach to modelling music education philosophy through the design and subsequent interaction of children and generative music making software. The research draws upon a 2004 case study where 600 four to eight -year old children were observed interacting with network improvisation using jam2jam software on laptops, electronic percussion and break dancing at Brisbane's Out of the Box festival of early childhood. The research examines the development of analytical tools which might be used to evaluate the qualities of meaning and engagement experienced by students by observing and recording evidence of personal, social and cultural meaning in dance, physical electronic percussion and laptop music performance. Issues about the nature and connection of gesture and sound are also raised through a comparison between the activities of dance, percussion and laptop manipulation. These data also generate implications for the further development of the software as a learning environment.

### **Introduction**

The idea of computer based modelling of theory is common in scientific research and mathematical modelling is also a well established means for researchers to observe how phenomenon act and interact under laboratory conditions where variables can be easily controlled and environments can be created where a phenomenon can be tested with frequent repetitions and varied contexts. In education and the social sciences this kind of experimental study is more difficult to create and hence the social sciences have developed post positivistic methodologies to handle the complexities of human systems. In the world of computer music, mathematical modelling has been used by many composers to model musical structures (Xenakis, 1991) and forms, recreate algorithms of musical style (Cope, 1992), create new and exciting timbres in synthesis (Chowning, 1973) and perform and compose music that might be impossible for human performers to play (Cage, 1961). Mathematics educators like Seymour Papert, the inventor of the computer language Logo for children- created micro worlds for children to experience philosophy, engineering and music making through creation of micro environments where students could construct their own objects using mathematical reasoning in a concrete and experiential environment (Papert, 1980, 1994, 1991). Recently, Andrew Brown at Queensland University of technology has created a java based musical programming language called *jMusic* (<http://jmusic.ci.qut.edu.au/>) and sets of online tools (<http://musictools.ci.qut.edu.au/>) that facilitate the creation of musical tools that are capable of performing musical transformations and analytical tasks as an adjunct to composition and creative music education. It is the purpose of this paper to examine the idea of modelling theory through software design and observing the interaction between music making software that creates focused environments or micro-worlds where music students can encounter useful learning experiences and teachers can design musical experiences that lead to musical knowledge and understanding. I will do this through a recent iteration of ongoing research using a *jam2jam* software case example which took place at a musical workshop called 'Jam' as part of a festival of early childhood called 'Out of the Box' (see Appendix 1) held in Brisbane Australia in 2004. Firstly I will briefly reiterate the background to the *jam2jam* study and describe the software focussing upon the development of *jam2jam* as a model of a 'living curriculum' where the software development responds to the needs of teacher control over the focus of musical knowledge and learning and teaching strategies combine in their adoption of philosophical principles of meaning and engagement.

### **Background to the study (See figure 1)**

*jam2jam is an online interactive generative music making software program developed by Brown, Sorensen and Dillon in 2002. The program utilises simple sliders and dials as an interface for controlling generative music algorithms. These algorithms were based upon popular music styles such as Hip Hop/Rap and Grunge/Guitar band styles. A survey was conducted among young people in Delaware, Ohio that suggested a range of popular performing artists and these recordings were used as templates for constructing the algorithms. These styles were analysed (Pratt, 1990) in detail by Brown and Dillon and a template for algorithms for three genres was developed that provided for the generation of distinct patterns of intensity, timbre and rhythmic/groove qualities. The specific polyphonic instruments timbres (Bass, drums, guitar, keyboards, percussion) were selected based on their likeness to those in the analysed works and are able to be controlled in real time by several students who interact on a network, the internet or solo. (Dillon, 2003)*

*jam2jam* enables quite complex musical interactions with algorithms that are based on popular music styles although it is not necessary to confine the generative structures to popular music ostinato as I will discuss later in this paper. The software gives access to collaborative music making/ networked improvisation through gesture (the movement of a screen based slider or dial). The movement of the slider controls degrees of intensity of activity and sound in time and space. For example in a *Grunge* song the activity of snare drum at it's lowest level might be a cross stick on the rim played on two and four whilst the most activity might be quaver triplets with a 'gated' effect on the snare sound and a significant increase in volume. Shifting the slider between these

two intensities allows a range of stylistically appropriate snare drum events that update within an eighth note of the movement of the slider. This kind of mapping of intensity has been undertaken for every timbre represented on the interface and each instrument can be played by a number of musicians simultaneously. Jam2jam uses a peer-to-peer network that can operate over a Local Area Network (LAN) or the internet. We call this kind of collaborative activity networked improvisation.

Whilst *jam2jam* is primarily software to be used for educational purposes it is important to reiterate here that both the design and development of the software were based upon distinct philosophical principles derived from two doctoral theses. My own thesis which examined the idea of giving access to meaning in music making proposes that musical experience needs to be personal, social and cultural (S. C. Dillon, 2001) and Andrew Brown who describes modes of compositional engagement (See figure 2) (Brown, 2003) based upon research that explored how expert composers interact with software and hardware in creative production. *jam2jam* software referred to these principles in its design and hundreds of repetitions of users interacting with the software were observed, analysed and integrated into the software development in several contexts. The software effectively models these theories and then through observation of student interaction with the software and teacher organization, generates further data about the theory itself and its robustness in fresh contexts and with different student/teacher demographics. There have been four cycles of development for *jam2jam* both in the USA and Australia over the past three years the iteration that is the focus of this paper occurred in June 2004 as part of Brisbane's Festival of Early Childhood 'Out of the Box' ( See Appendix A) where six hundred three to eight-year old children interacted with the software alongside hip-hop/break dancing and electronic percussion activities in fifty-minute sessions which will be described in detail in the methodology to follow.

### Methodology

As this approach to research does not fit neatly into existing 'off the shelf' methodologies we have adopted a new approach to method and data analysis called SoDaR:

*'where researcher and student understanding and learning is exposed through interaction with activities with specifically developed software. The SoDaR methodology involves the concurrent cyclical development of the theories, activities, and software.'*

*The SoDaR methodology has three stages;*

- 1) identifying the learning opportunity for which software development is required,*
- 2) design and production of the software, and*
- 3) implementation and refinement in an educational setting. Within each of these three stages there are processes of description, data collection, and reflection. (Brown, 2004)*

In this current cycle of activity the learning opportunity builds on the previous design of *jam2jam* as a networked improvisational tool for children. The specific case involved an opportunity to observe a context where varying degrees of gestural input could be compared in terms of their meaningfulness, ability to engage students and educational effectiveness. Design and adjustment to design occurred within this cycle of intense use. We were also able to observe further refinement of the software and curriculum approaches to its use through teachers other than ourselves using the software that provided curriculum design data.

### Description of the case

The 'Out of the Box' festival is an internationally acclaimed biennial event held at the Queensland Performing Arts Centre and specifically aimed at children aged between three and eight years of age. Our research took place as part of a workshop event called 'Jam'. The following was the workshop overview:

*The jam workshop will introduce children to digital sound production through constructing music using jam2jam software on Apple laptops via a wireless intranet and DJ style sampling technology. Children become live DJ producers and participate in a continuous dance party exploring basic mixing concepts that control the rhythmic groove, timbre, texture and dynamics of a generative techno dance piece. Children will be able to jam with their online neighbours creating live dance music and respond through expressive dance facilitated by a hip-hop dance educator as they rotate between sound-making and dance experiences. (Appendix A)*

*Jam* consisted of three inter related activities:

- 1) playing with *jam2jam* on a Local Area Network (Apple airport) and amplified through speakers.
- 2) Playing with electronic instruments and DJ Microphones ie. amplified guiro, claves and percussion sample triggers, theremin etc.
- 3) A hip hop/ break dancing activity.

Participants rotated through each activity. The music made by the interaction between the percussion and jam2jam performers was used as a continuous pulse by the dancers to rehearse and perform their routine. Three coaches supervised the participants one for each activity and students rotated in twenty-minute cycles between music and dance activities with a performance to parents, who were seated on the floor in the centre of the room. Each session held between 30 and 36 participants with three sessions per day for six days.

The significance of this sample is firstly the number and intensity of the interaction with the software and secondly the opportunity to compare the engagement with the direct kinaesthetic experiences of dance and more familiar use of un-tuned percussion and instruments that required less abstract means of sound making such as hitting, scraping and hand gestures that result in a direct sound. Data was collected from coaches reflections and Digital video footage of sessions and exposed to analytical tools to focus and organise data.

### **Analytical tools**

*Students defined personal meaning as a communication between self and music making.*

***Social meaning:** was warmly outlined as a 'deeper way of knowing'. Participants described the process as getting to know other members of an ensemble through the music, through their expression, the commonality of the musical experience and the challenge of the task rather than words alone.*

***Cultural Meaning:** is influential in the sense of self, the sense of self and others and reflects personal and community character. It is about expressiveness and the reciprocal interaction that both the artistic product and the maker have with the community. (S. Dillon, 2004)*

The above-mentioned definitions of the meaning were found to be inherent in musical activity in a long termed doctoral study in 2001. They were used as a basis for the design of jam2jam to ensure building meaningfulness into the software interface and development. Observation of interaction with users presented an opportunity to observe the phenomena of meaning demonstrated by users as well as facilitated by the interaction with software which suggests that the three notions of personal, social and cultural might be useful analytical tools to describe, categorise and theme observations of meaningful music making. As a tool for data analysis this allows both an opportunity to gain further evidence of the concepts of meaning and a means of analysing the quality and nature of interaction.

Brown's notions of modes of creative engagement (Brown, 2003) derived from a doctoral study that examined the modes of interaction between professional electronic composers and their tools provides a useful analytical framework for describing and categorising the relationships between music makers and their production tools. This model as represented in figure 2 enables a detailed observation of this relationship.

**Player:** describing the role of the music maker as an expressive maker of sound,

**Explorer:** a compositional/improvisers role where the user playfully experiments with expressive gestures and associated musical outcomes.

**Selector:** refers to making creative decisions about the material that the player might use in the creative process.

**Audient:** refers to the sensory perception and analytical understanding of sound as perceived as sonic representation,

**Director:** refers to the control that the user has over the creative materials.

**Instrument, Model, Generator, Container and Tool** define the changing function of the creative idea or expressive medium/instrument in the process of creative engagement. The terms themselves are self-explanatory and we can see in this model that the role changes depending on the kind of creative process at the time. What is important here is being able to identify the modes of engagement and the emphasis upon these in ways that enable expressive control and production that is meaningful to the student and the community. (Brown, 2000, 2003)

The model was also used in the design of jam2jam and was also integral to the observation and feedback derived from previous iterations of the research and development of jam2jam.

These tools provide frameworks for observation and a language to describe interaction and meaning that was further enhanced by the immediacy of the action feeding back research into design of the lesson structures and into the software design. A significant difference in this iteration was the use of facilitators or coaches rather than teaching/facilitating the sessions ourselves which allowed a further aspect of interaction from a curriculum and curriculum interpretation point of view.

### **Discussion of emergent themes**

#### Engagement and meaning

Parents, children, Administrators and facilitators all commented effusively about the degree of engagement and meaningfulness of the encounters with the jam workshop. Interestingly a distinction between the activities of dance, electronic percussion and using jam2jam on laptops was rarely made.

*The highlight would have to be a young boy who came up to me afterwards and said that he had “the best time EVER!” I knew that he was into the workshop, and very cheery and present – making eye contact with me and smiling, but I was frankly surprised that he was experiencing so much joy. This made me consider the many other young kids who expressed their enjoyment at the time to whatever degree. (Ande Foster: Facilitator)*

*I think that the kids enjoyed the variety of activities and saw little distinction between dancing, percussion and software operation. To them they were all activities – fun things to do.*

*I was impressed by the capacity of the students to learn the dance/music activities quickly and then operationalise them. (Andrew Brown observer/ software developer)*

Rene the jam2jam facilitator did however observe a difference in the kind of interaction:

*The level of interaction was similar – kids are kids, and they seemed to engage with most things... However the type of interaction was quite different. When using the computers, they lost connection to the outside world to a certain extent – it was much more difficult to give directions once they were using the computer. When dancing or playing instruments however, their attention was mostly on the facilitator (Rene Wooller j2j facilitator)*

Interpreting these observations is important because the students demonstrated an intense degree of engagement with the laptops and with the chaotic sounds of three simultaneous workshops it was important that they concentrate on listening and connecting with the sound they were making and associating the gesture with the sound which in a sense underlines the abstractness of the interface when compared to the directness of banging percussion or the interpretive movement of the dance activity. Jam2jam participants were also responsible for the groove that held the room together and so the concentration and ‘other world’ focus suggests the multiple roles of explorer, player and director as descriptions of the modes of creative engagement and intense personal meaning as suggested by the ‘lost connection to the outside world’ the social connection becoming more apparent as the sense of control and connection between sounds and gesture and the associated *audient* mode that was partially due to the chaotic nature of the activity and sounds. What was clear from this was the need for attention to curriculum design and implementation to allow the modes of engagement and meaning to be more discrete and dynamic.

#### Implications for Curriculum design

*On the whole, I think the curriculum was well designed. Considering the workshop ran for the first time, and we received several compliments on the good planning of the activity from teachers and parents, I think we are onto a winning formula. (Ande Foster)*

The perception of the curriculum design by the facilitators parents and organisers was indeed a positive one. The movement between activities offered a smorgasbord approach to short and intense activity.

*It worked quite well switching from a totally physical activity, to a musically physical activity, to a musically intellectual activity. This provided a complete spectrum of experience. (Rene Wooller j2j facilitator)*

Nevertheless the separation of activity into discrete and focused mini workshops was observed:

*I think acoustic percussion is sufficient, and the electronic percussion is cute but unnecessary. Better coordination of the overall session into mini-sessions might help make more sense to kids. For example a more clear delineation into ‘practice’ then ‘perform’ times for each of the three groups. This would make 6 distinct sections, with an MC perhaps commenting (with a microphone) at each break. Changes to jam2jam as mentioned above have or are almost completed. There could be a vocal (rap) element. (Andrew Brown observer/ software developer)*

The wide range of ages and social self-consciousness of older boys also had a marked effect on what was possible in terms of motor skill and communication levels:

*If any difference were perceptible it would only be in the age group of 7-8 YO boys who thought they were too cool to dance. Also having mixed age groups affected the dance section in particular. Different skill levels made it difficult for the facilitator to make a cohesive routine that was achievable by all of the*

children, and this sometimes left the little kids disengaged.

This further suggests the need for more discrete sessions, which allow focused engagement on each activity. The degree of control needed by the facilitator is also an important observation. Whilst dance presented the greatest demand on the facilitator the abstract and extreme focus of the *jam2jam* players presented another concern:

*The dance was the most 'directed' and centralised around the instructor, the percussion was somewhat centralised, and the j2j activity was the least reliant on the continual input of the instructor. This may have serious implications for classroom management (as all keyboard-lab child minding loving teachers know). This difference in engagement also results from the degree to which the activity is structured – j2j provides clear pathways for action and prevents significant deviation from them, whilst dancing is potentially open-slayer and so the director is required to continually delimit the space of potential actions. (Andrew Brown observer/ software developer)*

What is reinforced here is that for meaning to be accessible the curriculum also needs to provide access to each aspect of personal, social and cultural meaning. It was only after comments made by the designers that the end session provide a discrete performance for parents that cultural meaning became accessible for participants who could display their instrument and dancing skills in a focused environment where parents and fellow participants could share in the meaning of the music making.

*More attention could have been paid to more clearly demarcating the session into smaller event with their own closure. (Andrew Brown observer/ software developer)*

*We also experimented with "performance time" which worked quite well in one or two of the workshops. Sometimes, depending on circumstances, this was more difficult, and we would not worry about it. Other times we did it, but the kids didn't really realise that they were doing a performance, or the tempo would change wildly, making for a bit of dance floor havoc. (Rene Wooller j2j Facilitator)*

The implications for software development refer to the teachers notes for the software where it should be made very clear that the lesson plan should provide access to three areas of meaning developed in discrete time allocations beginning with personal exploration and then gaining control over collaborative activity and finally presenting and improvisation to an audience or making a CD recording of the result as we did in our first iteration of this research. When asked whether they noticed any differences in levels and type of engagement between workstations?

The response was:

*Between kids yes, but not between workstations. Generally students were highly absorbed in the j2j activities. There was some confusion at times. I expect that if the activity went for more than 10 mins then a goal more developed than 'play' would need to be provided.*

The suggestion here is that any further iteration will need to look at more in depth and long termed engagement with the interface like that perhaps of an ensemble use.

#### Implications for software design

The implications for software design were focused upon teacher and curriculum in this iteration. There was a need for teacher control over some parameters so students could focus on control over specific elements:

*It would be beneficial to be able to lock screen sets so children assigned to control one sound would not stumble upon the other pages of the program that other kids are controlling. This could prevent the virtual tug-of-wars that I observed on occasion. (Ande Foster)*

Andrew Brown who corrected faults and integrated new design features into the software in the cycle of research and post case suggests:

*The software changes resulting from the event included the reconfirmation that an even simpler interface would be useful. That external hardware controllers would add a degree of concreteness to the operations and so should be supported, and to assist in group activities various aspects of the functionality should be able to be hidden – in particular the transport and chat panels. (Andrew Brown observer/ software developer)*

The implication here is that we need an interface that allows elements of to be turned on and off to focus the aural perception of players and allow a degree of stability to the learning.

Primarily the data gathered from this iteration with over 600 players and new facilitators refers to focusing the learning activity through switch on/off menu features, the design of lesson checklists as associated materials for

using the software that allow and promote discrete modes of engagement and meaning. What was surprising was that despite the chaotic and noisy environment with three simultaneous activities engagement and meaningful outcomes were clearly observed in repeated sessions by facilitators and in the digital video recordings as well as through the comments of parents, organisers and observers. Nevertheless for these positive aspects to be sustainable there will be a need to make the adjustments to both software design and curriculum. There is a further need to examine a longer period of engagement with a small group or ensemble to establish meaning and engagement beyond the novel.

### **Jam2jam and the potential for music education**

*The value of software for education is most clearly evident when the computer opens up new opportunities for music making not previously possible or accessible. Software adds greatest value when it makes a qualitative, rather than quantitative, difference. For example, the combination of generative music algorithms, and Internet connectivity were two aspects of computing technology that added to the unique features of the jam2jam software. (Brown, 2004)*


The educational applications of jam2jam become clearer with each iteration which enriches the concept within data from fresh contexts. Further iterations beginning in late 2004/5 include:

- 1) Use as a participatory-networked aural musicianship tool.
- 2) Networked improvisation to connect remote aboriginal communities and city schools.
- 3) Jam2jam taught to 500 pre service primary general classroom teachers as a tool for non-music experienced teachers to use in cross-curricular studies. These teachers are developing lesson plans for use in the general classroom.
- 4) Jam2jam as a basis for electro acoustic ensembles where acoustic instruments play/improvise with a laptop/USB interface musician who controls the electronic aspects in a DJ like manner in real time.
- 5) The creation of networked improvisational music environments (NIME). Using algorithms from minimalism, Chaos/ stochastic, DJ-ing, electro acoustic music, music concrete, world music origins etc to enable an immersive and collaborative interaction with music making that is structured by a learning focused and designed interface that equates the gesture and the resultant sound with musical knowledge.

It is this last idea which holds the most exciting possibilities for music education and technology. The creation of virtual music environments where students can experience previously abstract musical ideas through gesture and interaction. Brown and Jenkins (Brown & Jenkins, 2004) performance of a 1972 Xenakis algorithm at the Australasian Computer music conference this year demonstrated that complex algorithmic music can be controlled and influenced through gesture using USB controller mixing desks and an interface that allows the player to control the outcome and participate in 'live' performance of complex music making. These structures, modes of control and interfaces can be relatively easily assigned to musical elements and musical styles which would provide a useful learning environment that would give access to experiential learning and expressive control over complex musical ideas.

### **Conclusion**

From a philosophical perspective there is evidence here that meaning and engagement can be modelled and observed as interactive components of a music learning experience. What has emerged most clearly from this research has been the need to link software design to curriculum theory and to teacher interpretation of curriculum and emphasise the importance of discrete access to meaning and modes of engagement. The problem of software being used as child minding activity when it is intensely engaging needs to be considered and the connection between curriculum and software needs to be clearly detailed in the design and production of educational materials. Further projects with this software should explore longer termed engagement and use with acoustic instruments such as a children's electro-acoustic ensemble would provide more knowledge outcome focused evidence. Whilst the current iterations are engaging and meaningful, a more detailed assessment of the knowledge gained and transformative effects software use has upon users would be an appropriate next step. Whilst demonstrated control, tasteful collaborative activity and effective performance are observable in current usage as learning outcomes there is a further need to examine long term effects. The potential of the concept however is exciting. If we consider the building of Networked Improvisational Music Environments (NIME) with associated contextual materials as immersive virtual learning, the opportunity to explore complex sound structures in a classroom or online presents an exciting direction for music learning.

**Note:** Shareware versions of  Jam2jam are available for Apple OSX and PC Windows XP users at: <http://www.explodingart.com/>

### **About the author**

Steve Dillon is a singer, composer and senior lecturer in music and music education at Queensland University of Technology in Brisbane. His major research foci revolve around creative practice as research, digital media portfolio systems, music education and meaning and the development of interactive music software for children.

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## **Appendix A Out of the Box overview of jam workshop JAM**

### ***Workshop***

**Age:** 4-8

**Date and Time:** Daily 10:30am, 11:30pm & 1:30pm

**Venue:** Playhouse Lounge

**Cost:** \$8

**Duration:** 45 mins

**Capacity:** 30

### **Workshop Overview**

The jam workshop will introduce children to digital sound production through constructing music using *jam2jam* software on Apple laptops via a wireless intranet and DJ style sampling technology. Children become live DJ producers and participate in a continuous dance party exploring basic mixing concepts that control the rhythmic groove, timbre, texture and dynamics of a generative techno dance piece. Children will be able to *jam* with their online neighbours creating live dance music and respond through expressive dance facilitated by a hip-hop dance educator as they rotate between sound-making and dance experiences.

### **Classroom Context**

Children will engage in manipulative play that allows them to arrange, compare and contrast sensory motor experience. Knowledge and understanding in the areas of music, sound, dance and technology will be extended and strengthened as children interact with music and audio technology materials for their own purposes and enjoyment. This workshop draws upon content and contexts from Key Learning Areas of The Arts and Technology. *Jam* will heighten children's listening and kinaesthetic skills and encourage children to respond to, enjoy and appreciate the personal, social and cultural aspects of group music making.

### Foundation Learning Areas

Thinking

Communicating

Understanding Environments

Cultural Understanding

### Education Queensland Priorities

**Productive Pedagogies – Intellectual Quality (Higher-Order Thinking, Deep Understanding, Substantive Conversation); Connectedness (Knowledge Integration, Connectedness to the World, Problem-based Curriculum).**

New Basics – Environments and Technologies (working with design and engineering technologies); Life Pathways and Social Futures (collaborating with peers and others, Learning about and preparing for new worlds of work, Developing initiative and enterprise); Multi-literacies and Communications Media (making creative judgments and engaging in performance).

### Suggested Topics

Sounds

Beat and rhythm

Electronic and acoustic music

How sound is made and how it travels

### Suggested Learning Experiences

Teachers may choose to extend this in depth by integrating a variety of learning activities from Key Learning Areas.

**THE ARTS:** Role-play DJs and radio presenters using appropriate language and vocal styles; identify different styles and forms of music they are familiar with; share their favourite music with each other; record themselves singing a variety of songs; make sound effects and record them on an audio tape; learn a dance specific to a particular piece of music or song; listen to a variety of songs and music scores and respond through movement to the moods evoked by each piece; respond to feelings music evokes through painting with different colours; build and re-enact an imaginary radio station.

**ENGLISH:** Listen to a variety of music evoking different moods and respond to the music through stories or descriptive statements; learn songs with distinctive rhyming sequences and innovate own lyrics.

**MATHEMATICS:** Listen to favourite songs, sort and arrange them according to their preference; and count beats.

**SCIENCE:** Learning activities could involve categorising songs.

**STUDIES OF SOCIETY AND ENVIRONMENT:** Focus on the interaction between sound/ music and society in our culture.

**TECHNOLOGY:** Design and make musical instruments using available resources and materials; learn how to use simple musical and recording equipment.

**HEALTH AND PHYSICAL EDUCATION:** Learn about hearing and how the human ear receives and understands sound.

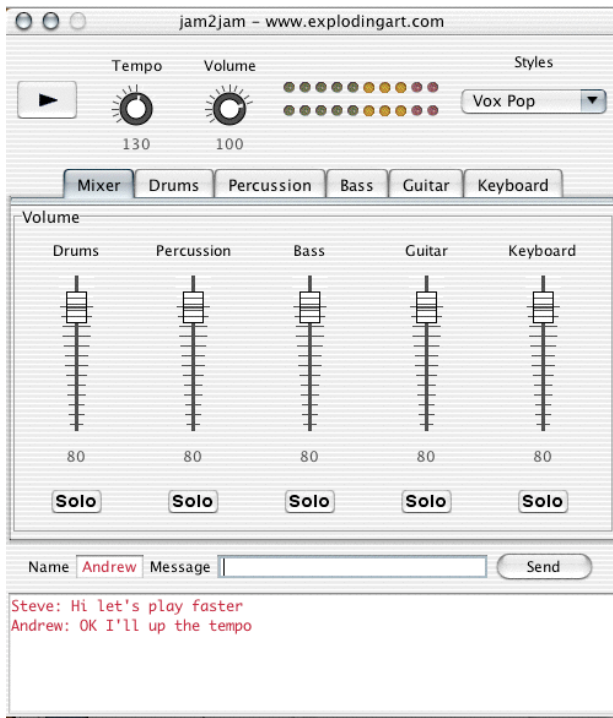


Figure 1 the *jam2jam* interface.

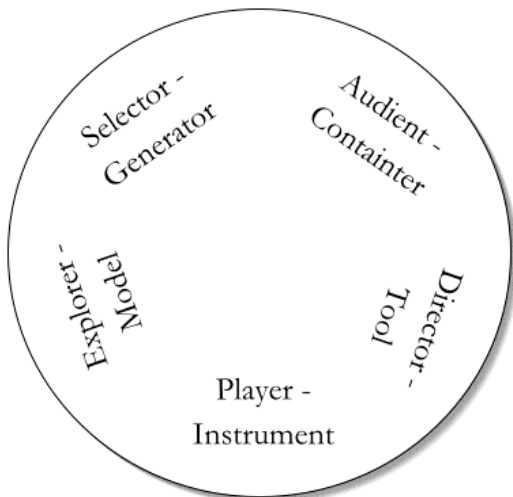


Figure 2 Brown's Modes of creative engagement