Music Maps: A graphically-mediated approach to developing children's music listening skills

Claire Conneely, B. Mus. Ed. (DUB)

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Declaration

I declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

Signed: _____

Claire Conneely, B. Mus. Ed. (DUB)
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'Musicing of whatever kind always includes another kind of doing, called music listening'

David Elliot (1995) *Music Matters* (p.78)

Abstract

This qualitative case study examines the use of a graphical computer interface as a facilitator of collaborative interaction during a music listening activity. It considers whether a graphically-mediated collaborative listening activity can engender the development of critical listening skills.

Graphic representations have an important role in music education, serving as a starting point for learning deeper listening strategies (Tan & Kelly, 2004) and providing a means of studying children's musical perceptions and conceptualisations (Elkoshi, 2002). Computer-based collaborative learning presents the opportunity to focus on peer-interactions in order to gain an insight into underlying mechanisms and complex cognitive processes (Dillenbourg, 1999; Littleton & Häkkinen, 1999). Graphical computer-based technologies enable meaningful, constructionist interaction, without the use of standard music notation, during collaborative music composition activities (McCarthy, Bligh, Jennings & Tangney, 2005).

This paper describes the design and implementation of *Music Maps*, a graphical interface that allows learners to construct graphic representations of their perception of a piece of music. It traces the progress of eight participants through an initial individual implementation stage and then through a second collaborative implementation stage. Data comprises participants' created maps, researcher observation notes, unstructured interviews and student-teacher and peer-peer dialogue.

Findings indicate that engaging in a graphically-mediated collaborative listening activity can engender the development of critical listening skills in children. A graphically-mediated collaborative approach promotes active, musical involvement and interactive dialogue among learners. *Music Maps* provides a medium for communication during a collaborative activity, whereby students can discuss, represent and demonstrate personal perceptions of musical sounds. Furthermore, the process of collaboratively assigning meaning to graphic representations facilitates the development of a shared perception and understanding of musical sounds. The findings also offer some alternative suggestions as to how music educators can attempt to firstly understand and subsequently develop students' critical listening skills.

Table of Contents

List of Illustrations

1. Introduction

1.1. Background and Context

Composing, performing and listening form the core strands of music education (Swanwick, 1979). A great deal of research in the field highlights the importance of attentive and critical listening for developing performance and composition skills. Recent research (Holloway, 2004; Smialek & Boburka, 2006) reveals positive gains in critical listening skills through the application of dialogue-centred, co-operative learning approaches.

Standard music notation is a difficult concept to understand, often presenting a barrier to learners in the acquisition of performing, composing and listening skills (Bamberger, 1991). In light of these difficulties, there is a great deal of interest in alternative forms of notation, particularly graphic representations. Graphical computer-based technologies enable meaningful musical interaction without the use of standard music notation during composition activities (Jennings, 2006; McCarthy et al., 2005). Results of a pilot project involving the use of a graphical computer interface indicate positive effects on children's listening skills (Conneely, 2006).

'Little is known about the processes that take place while listening to a composition' (Aiello, 1994, p.274) and it is very difficult to conduct adequate research on music listening skills (ibid; Kratus, 2004). Computer-based collaborative learning presents a solution to this problem, as it offers the prospect of gaining insight into learners' complex cognitive processes (Dillenbourg, 1999; Littleton & Häkkinen, 1999).

1.2. Research Questions

Having considered the points above, there is a clear case for examining the use of a graphical computer interface as a facilitator of collaborative interaction during a music listening activity, in order to answer the following overarching question:

- In what way does engaging in a graphically-mediated collaborative music listening activity engender the development of critical listening skills in children?

From this principle question the following sub-questions arise:

- Which musical features are most salient to children engaged in a graphically-mediated collaborative listening activity?

- What insights into children's perception can be gained from collaboratively assigning meaning to graphic representations?

- What is the role of the teacher in engendering the development of critical listening skills during a graphically-mediated collaborative activity?

1.3. Investigation Methods

With these research questions in mind, the researcher designed *Music Maps*, a graphical computer interface which facilitates the construction of graphic representations in response to listening to a piece of music. There were two stages of implementation, involving eight participants. Data analysis reveals that a graphically-mediated listening activity leads to enhanced perception in children. A collaborative approach to using the graphical computer interface offers some worthwhile contributions to methods of understanding and developing children's critical listening skills.

1.4. Dissertation Roadmap

This paper will firstly present an overview of the literature in relation to music listening, the argument of standard music notation versus graphic representations, the various methods of investigating and measuring music listening and the merits of computer-based collaborative learning and graphical computer interfaces.

In light of the research questions arising from the literature, chapter three outlines the design and technical development of a graphical computer interface, *Music Maps*. Chapter four addresses the relevant research methodology employed during the implementation stage.

Chapter five presents the main findings arising from an in-depth analysis of all available data sources, followed by a discussion, in chapter six, of some findings in detail. Finally, chapter seven draws some conclusions and makes suggestions for further research in the field.

2. Literature Review

2.1. Overview

This chapter will firstly examine literature in relation to music education before specifically discussing music listening. A section presenting the arguments in relation to music notation versus graphic representation follows. A further section outlines some of the problems associated with conducting music listening research and discusses the merits of computer-based solutions. The chapter will conclude by stating the aims and research questions of the project.

2.2. Music Education

The skills of listening, composing and performing comprise the basic structure of music education (Swanwick, 1979). These three skills form the core strands of the music curricula of primary and post-primary schools in Ireland (Government of Ireland, 1993, 1996, 1999). There are also three key principals of music education – care for music as discourse, care for the musical discourse of students and fluency first and last – to ensure that students and teachers 'engage in lively music education transactions' (Swanwick, 1999, p.44). In order for the music student to become directly engaged in a creative musical experience, it is essential that these key principles remain the focus of music pedagogical practice.

A great deal of music education research highlights the correlation between listening, composing and performing skills. Learners will acquire a deeper meaning from composing and performing activities, if the skill of critical listening can be cultivated (Paynter, 1992). Focusing on *knowing how* to engage in listening becomes the means for *knowing about* the music of performance and composition activities (Bamberger, 1994). Helping children develop the ability to listen to music with interest, attention and understanding should be an important goal of music education (Sims, 2005; Sims & Nolker, 2002).

The traditional role of music education (to promote and enable active musical involvement) is based on 'a narrow view of what "active" means' and often leads to 'equally narrow opportunities for musical learning' (Reimer, 2003, p.240). One of the purposes of the

current study is to develop a music listening activity which will promote and enable active musical involvement among students.

2.3. Music Listening Skills

2.3.1. Introduction

This section will firstly explain what is meant by music listening and what is considered a music listening experience. Jeanne Bamberger's work in the area of music perception will also be discussed briefly. To conclude, there will be a discussion on cooperative learning approaches to music listening.

2.3.2. Music listening

The nature of music listening is difficult to define. Listening is a term that researchers use interchangeably with several others, such as hearing, audition, aural skills, perception and cognition – words often used to explain the meaning of music listening. Many music educators regard the inventiveness of composing and performing as a stark contrast to the often passive nature of listening (Reimer, 2003).

However, Elliot (1995) contends that music listening is cognitive and constructive, requiring listeners to interpret and construct auditory information, based on personal understandings. Listeners have the ability to move from a passive hearing stage through to an active listening-for stage (see Figure 2.1).

Figure 2.1 'Degrees of Audition' (Elliot, 1995, p.80)

It is essential that music teaching and learning is structured in a way that reflects and can develop the 'multidimensional form of thinking and knowing' (ibid, p.101) that is music listening.

2.3.3. What constitutes a music listening experience?

The combination of perception (noticing) and reaction (feeling) constitutes a music listening experience (Reimer, 1985). While listening, an individual creates their own experience by selecting which musical features to attend to and by shifting attention amongst a variety of simultaneous factors in the aural stream (Kratus, 2004). Experiences of listening to music are shaped by a combination of enculturation (either from simple exposure to music or due to formal music training) and cognitive constraints (Thompson & Schellenberg, 2006).

Beament (2001) defines pitch (high/low sounds), melodic intervals, harmony, loudness, rhythm and tempo (speed), instrumental sounds and direction as the principle structures of music perceived during listening. Similarly, Liatz (2003) identifies the perception of pitch, pulse, rhythm, melody and harmony as essential for attentive listening to pieces of music. Melody is the musical element most easily recognised, reproduced and remembered from listening, because it is perceptually the most salient (Dowling, 1994). During listening, musicians group sounds according to individual perceptions, often influenced by the contour, timbre, rhythm, intensity and tempo of a melody (ibid).

2.3.4. The development of perception

Much of Bamberger's (1994, 2003, and 2005) work to date concentrates on the development of music perception. Music educators should focus on the evolution, rather than the evaluation, of listening skills and should provide a framework in which students can fully describe and account for their individually tacit and intuitive perceptions of music (Bamberger, 2003). There is a great need to help students learn to make multiple hearings of rhythms and melodies (Bamberger, 1994). Learners need to firstly become aware of their own hearings and recognize to which aspects they are giving priority, in order to develop the ability to choose selectively and knowingly about possible hearings (Bamberger, 1994, 2005).

The question of whether there are differences between what people hear in listening to the same pieces of music (Bamberger, 1994) leads onto a debate in relation to whether participation in group listening activities affects children with diverse patterns of individual listening and whether there is a relationship between an individual's performances during group activities compared to solitary activities (Sims & Nolker, 2005).

2.3.5. Critical listening

Critical listening is a combination of perception and critical thinking (Smialek & Boburka, 2006). There is a guided learning framework for the development of critical listening skills, which comprises an analytical stage, a judicial stage and a final creative stage (Pogonowski, 1989). Underpinning this framework is the theory that dialogue is of utmost importance for developing students' critical thinking and meta-cognition (an awareness of one's own thinking processes). A dialogue-centered listening activity enables students to learn by discovery, as they are invited to describe and critically discuss what they can hear in the music (Allsup & Baxter, 2004).

2.3.6. Group-based listening activities

Recent research (Holloway, 2004; Smialek & Boburka, 2006) in the field of music education reveals positive gains in listening skills through the application of co-operative learning theories. Johnson and Johnson (1989, 1999) promote co-operative learning as more effective than competitive or individualistic learning. Actively working in groups leads to 'positive, constructive interactions among students' (Holloway, 2004, p. 90) and a significant increase in music listening achievements. A consistent co-operative approach to music listening exercises is effective in developing critical listening skills through 'increasing student's level of engagement, facilitating peer teaching and encouraging them to ask for assistance' (Smialek et al., 2006, p.71).

The terms cooperative and collaborative, often used interchangeably, describe a situation where two or more people learn together. However, the division of labour among group members is the distinct difference between the two terms – in collaboration partners do the work together (Dillenbourg, 1999). Collaboration necessitates that participants are engaged in a coordinated effort to solve a problem or perform a task together (Teasley & Roschelle, 1993). One of the purposes of the current study is to consider whether a collaborative approach to music listening activities can engender the development of critical listening skills.

2.4. Music notation

2.4.1. Introduction

This section will begin by explaining the standard music notation system used in formal music instruction. Some of the problems and limitations of standard music notation will then be discussed, leading onto the final section, which will deliberate an alternative solution offered by invented notations and representations.

2.4.2. Standard music notation

Standard music notation is a fixed reference system, which evolved over time in an effort to externalize musical knowledge in some publicly accessible form (Bamberger, 1991). It is a systematic framework 'within which the noticeably invisible relations of pitch and time that are necessarily experienced as continuously going on, come to be represented as spatial, static, and invariant properties' (Bamberger, 2004, p.144). Standard music notation provides a system of communication between composer and performer.

Many pedagogical approaches to music are inherently based on the assumption that learning music is synonymous to learning standard music notation (Barrett, 2005, p.118). Literacy skills are very often unnecessary and should not be the sole aim of music education (Swanwick, 1999). Literature studies and skill development are secondary components, acting in a supporting role to the principal 'musical' skills of composing, performing and listening (Swanwick, 1979).

2.4.3. Difficulties and limitations of standard music notation

Standard music notation is a difficult concept to understand, often causing so much confusion for beginners that it is the point at which they become disinterested in learning music (Bamberger, 1991). An early emphasis on notation may disguise and discourage children's powerful intuitive responsiveness to certain musical parameters, particularly rhythm and pitch (Bamberger, 2005). Music notation should 'enable' rather than 'disable' musical thinking and practice (Barrett, 2005).

Standard music notation is a constraint that can affect the listening process. Notational representations are often incomplete – 'they are partial to certain aspects of the phenomena

while ignoring others' (Bamberger, 2004, p.2) – and 'units of description, as embodied by notations-in-use, strongly influence units of perception' (Bamberger, 1991, p.15). A pedagogical approach that introduces concepts through direct intuitive interaction with music activities that are not bound to standard music notation has shown to be beneficial to the learner (Bamberger, 2000).

2.4.4. Invented Notations and Representations

2.4.4.1. Introduction

In light of the difficulties and limitations associated with standard music notation, the concept of invented notation has received a great deal of attention in music education research. This section will firstly examine the use of invented representations in science and mathematics education and then discuss the insights into children's perception of music and construction of musical meaning afforded by invented representations.

2.4.4.2. Invented representations in science and mathematics education

Invented representations have long been a topic of interest in the area of science and mathematics education research (Palmer, 1977; Kaput, 1987; Sherin, 2000; Granados, 2001). The value of invented representations lies in the learner's ability to make a correspondence between a 'representing' world and a 'represented' world (Palmer, 1977; Kaput, 1987). Many of the difficulties that students encounter in learning often relate to a failure to make appropriate correspondences between the two worlds (Kaput, 1987).

Sherin (2000) examines the capabilities of students in relation to representational forms and discusses the various classes of constructive resources that contribute to a student's ability to create symbolic representations. By inventing individual, novel representations, students can develop a fuller understanding of the purposes and underlying rationale of conventional scientific and mathematical representations (ibid).

2.4.4.3. Invented notations and representations in music education

Researchers in the field of music education employ invented notations to explore children's comprehension of rhythm (Bamberger, 1991, 1994) and to construct an understanding of children's meaning-making as notators (Barrett, 1997). Similar to standard music notation, invented notation provides a means of 'conserving, communicating, conceiving and constructing musical meaning' (Barrett, 2005, p. 137).

Other research on invented notations examines the effects of active versus passive listening (Gromko & Russell, 2002; Gromko & Fung, 2001) and the perceived match between visual parameters and auditory associations (Lipscomb & Kim, 2004). Invented notations of musical sounds afford an insight into individual listening strategies (Tan & Kelly, 2004). Children's invented notations are an important means by which teachers can study pupils' musical perceptions and conceptualisations (Elkoshi, 2002).

Based on positive results from recent research, the current study aims to examine whether the use of graphical representations, in a collaborative-based music listening activity, can afford insight into children's perception of musical sounds and engender the development of critical listening skills.

2.5. Investigating and Analyzing Listening Skills

2.5.1. Introduction

This section will firstly present a summary of the problems associated with investigating and analyzing music listening skills and explain the challenges inherent in designing an research project on music listening. Some possible solutions offered by computers and technology will then be discussed.

2.5.2. Problems associated with investigating listening skills

By discovering as much as possible about the influences that affect young children's music-listening responses and how these responses develop, teachers can be better prepared to assist children in becoming more attentive, appreciative music listeners (Sims & Nolker, 2002). However, several studies (Aiello, 1994; Wolpert, 2000; Sims & Nolker, 2002; Kratus,

2004) have drawn attention to the fact that it is very difficult to conduct adequate research on music listening.

Listening is very much a 'covert act and all means to measure or describe it (e.g., movement, drawing, writing, improvising) are tempered by the modes of communicating this inner activity' (Kratus, 2004, p.271). When listening to a piece of music, hearers focus on certain aspects and disregard others, which may be due to personal choices or the influence of certain outstanding features in the music, such as melody (Aiello, 1994). Therefore requesting listeners to focus on particular aspects of music cannot resemble possibly listening as it occurs at an individual's discretion (ibid).

The design of an experiment must account for the freedom of the listener and the complexity of the musical structure (Aiello, 1994). The question of 'what do people hear' is more important than 'what can people hear', in order to reveal what listeners pay attention to when left to their own devices (Wolpert, 2000). Since listening cannot be observed directly, one of the primary challenges of research in this area is developing a research strategy that is observable and measurable and that will directly engage children with musical sounds (Sims, 2005; Sims & Nolker, 2002).

2.5.3. Computer-based solutions

2.5.3.1. Introduction

This section will begin by discussing the application of computer-based tools in constructivist learning environments. The merits of computer-based collaborative learning will then be summarised, followed by a brief discussion of graphical computer interfaces in particular. To conclude, this section will outline the aims and research questions of the current study.

2.5.3.2. Computer-based tools to support constructivist learning

According to the principles of constructivist psychology, learning is a process in which individuals actively construct their own knowledge (Alessi & Trollip, 2001). Applying a constructivist view to the use of computers in education, Seymour Papert's research yields that children can learn to use computers in a masterful way, which will change the way they

learn everything else (Papert, 1993). Constructivism emphasises the active process of learning, through exploring, experimenting and asking questions (Alessi & Trollip, 2001). Constructivist theorists support the use of computer-based tools with which learners can design and construct their own knowledge (Jonassen, 1999).

2.5.3.3. Computer-based collaborative learning

The constructivist learning theory also highlights the importance of collaborative learning. As already referred to above, there is a general consensus among researchers that collaboration involves the construction of meaning through interaction with others, characterised by a joint commitment to a shared goal (Littleton & Häkkinen, 1999). Recent developments in computer technology have not only promoted new forms of collaborative activity among learners, but have also highlighted the nature of our human capabilities as collaborative learners (ibid).

Computer-based collaborative learning, grounded in the cognitive-developmental theories of Piaget (1932) and Vygotsky (1978), facilitates peer interaction – discussion, explanation, demonstration – which in turn facilitates children's understanding and learning. Computer-based collaborative learning offers the opportunity to focus on such interactions in order to gain an insight into the underlying mechanisms and complex processes at work (Dillenbourg, 1999; Littleton & Häkkinen, 1999).

2.5.3.4. Graphical computer interfaces

Concept maps provide spatial, network-like representations for knowledge construction, organisation and presentation. Weyde and Wissmann (2004a, 2004b) argue that images should be included in mind maps, based on the premise that memory for visual imagery is stronger than textual representations. Therefore, information recorded visually, as well as verbally, is more memorable. The incorporation of graphics into mind maps gives users enhanced means of representing their knowledge and with such an abstract activity as music listening, the visualisation and interaction provided by a mind map helps users create and make use of their internal cognitive representations (Weyde & Wissmann, 2004b).

Sherin (2000) recommends the use of ICT tools for the creation of invented graphic representations in mathematics and science education research. Jennings (2006) examines the teaching and learning of music composition by analysing the behaviour and processes of work of both students and teachers whilst using graphical computer technology. Results of a pilot project reveal that the use of a computer interface in order to construct graphic representations of musical sounds engenders enhanced perception of specific musical structures (Conneely, 2006).

2.5.3.5. Graphical computer-based collaborative learning

In the field of science and mathematics research, Granados (2001) employs a computer program as a facilitator of collaborative interaction in the creation of representations of geometric activities. Graphical computer-based technologies enable meaningful, constructionist interaction, without the use of standard music notation, during a collaborative music composition activity (McCarthy et al., 2005).

2.6. Implications for Research

Having discussed the literature in relation to the development of critical music listening skills, the merits of graphic representations and the benefits of computer-based collaborative learning, there is a clear case for investigating the use of a graphical computer interface as a facilitator of collaborative interaction during a music listening activity. The author proposes that a graphically-mediated collaborative activity will not only promote and enable active musical involvement among students, but will also afford some insight into children's perception of music.

The study will examine whether engaging in a graphically-mediated collaborative music listening activity can engender the development of critical listening skills in children. A number of sub-questions also arise in relation to which musical features are most salient to children engaged in a graphically-mediated listening activity and the associations they make between these musical sounds and graphic representations. A final question relates to the role of teachers during a graphically-mediated collaborative listening activity and the extent

to which this can provide insight to music educators in relation to the development of children's critical listening skills.

3. Artefact Design

3.1. Introduction

Chapter 2 presented a review of the literature in relation to music listening as an essential component of music education, the difficulties and limitations of standard music notation and the problems associated with investigating and analysing music listening skills. The aim of the current study is to design a computer interface that presents a set of graphical icons to users, with which to construct a representation of their perception of musical sounds. The aim of the artefact is not only to engage learners in an active, collaborative music listening activity, but also to simultaneously provide for a means of close observation and inquiry on the part of the researcher.

This chapter considers the design of a graphically-based artefact, entitled *MusicMaps*, for use in a musical learning experience. The first section will outline the design of the artefact in relation to technical requirements, followed by an overview of the user functions of the interface.

3.2. Technical Requirements

This section will discuss the design of the artefact in relation to the technological applications employed, namely Macromedia Flash and Dreamweaver, Javascript and Audacity.

3.2.1. Macromedia Flash and ActionScript

In order to achieve a learning experience of maximum interactivity, the researcher decided to design the artefact using Macromedia Flash Professional (Version 8.0). Flash is a multimedia authoring program, which includes ActionScript 2.0, a programming language used to create interactivity through animations, audio, text and event handling. In the development of the artefact for the current study, ActionScript facilitated the use of variables, functions and case conditions for the duplication and rotation of graphical icons (in the form of movie clips).

The pre-production stage of the design process involved the creation of storyboards to organise the navigation and general structure of the artefact. These plans resulted in the decision to create several individual Flash movies – one map-making area for each piece of music, an opening screen and a help page.

3.2.2. Audacity

In their investigation into the listening strategies of trained and untrained musicians, Tan and Kelly (2004) advocate the use of short, but complete pieces of music, and insist that this is important in order to give listeners the chance to form a complete mental representation of a piece of music in its entirety. In choosing the musical material for the artefact and learning experience, the current study adopted similar principles, opting for the use of short, yet complete sections from larger musical works to serve as standalone pieces of music.

The researcher made a conscious effort to select pieces that differed somewhat in musical style, choosing compositions from the classical, jazz and popular music genres. Appendix A contains a complete list of pieces and recording sources. The researcher also considered the instrumentation of each piece of music, in an attempt to scaffold the development of participants' listening skills as they progressed through the activity. Hence, Piece 1 consists of one, solo instrument, Pieces 2 and 3 contain three instruments and Pieces 4, 5 and 6 contain four instruments or instrument groups.

Audacity is free, open source software for recording and editing sounds. It supports the importing, editing and exporting (in several common file formats) of sound files. For the design of the artefact, the researcher imported the selected sound files into Audacity in mp3 format and edited each one to approximately 1 minute 30 seconds in length. As it is possible to import mp3 sound files into Flash, each of the six newly created musical extracts were exported from Audacity in this format.

3.2.3. Macromedia Dreamweaver, HTML and Javascript

In order to ensure a wide range of accessibility, the researcher decided that the artefact should be web-based. Upon completion of the individual Flash movies, the researcher

imported each one into Dreamweaver and embedded it into a webpage. HTML links on each webpage made for easy navigation between the opening screen and the map-making area for each piece of music.

Javascript is a scripting language generally used in websites to write functions embedded in HTML pages and to perform tasks not possible in HTML alone. A common example of the use of web-based Javascript is to 'pop-up' a new window, the size, position and appearance of which have been controlled in the programming script. In the design of the artefact for the current research project, the researcher used Javascript for a help link within the artefact. A help button should always be visible to learners, reminding them that help is available and that it is possible to return to directions at any time (Alessi & Trollip, 2001, p. 77). Javascript added to the HTML of each webpage enabled a help link to open in a new pop-up window. This facilitated participant access to the help instructions at any stage during the listening activity, without having to abandon work in progress (see Figure 3.1).

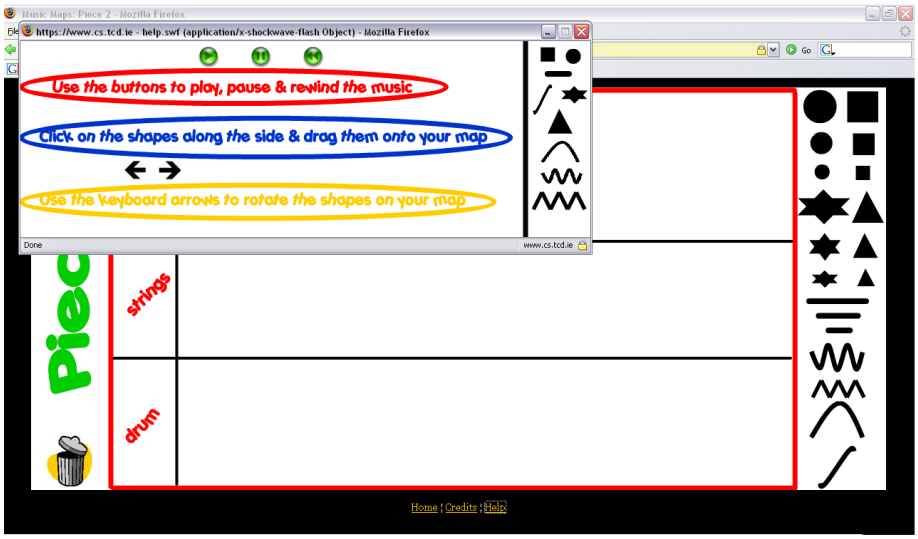

Figure 3.1 Pop-up Help Screen within a *MusicMaps* window

3.3. User Functions

This section will outline the principle functions of *MusicMaps* available to users and will also refer to specific literature that informed the design process.

3.3.1. Title Page

Figure 3.2 shows the opening screen of the artefact, *MusicMaps*. Considering that this would be participants' first contact with the interface and in order to attract their attention, the use of colour and images were important design considerations. The design of the title page adopted specific suggestions in relation to colour, such as a strong contrast between background and foreground colours and the use of colour for emphasis (Alessi & Trollip, 2001). The purpose of the images of musical instruments was to attract users' attention and also to function as a rollover link to the mapmaking pages for the pieces of music.

In relation to text, the researcher followed recommendations to keep the title page short and to the point, and to make it absolutely clear to users how to continue the program (ibid, p.49). The title page provided one concise instruction for users: '*Click on one of the instruments to start*', the text emphasised by the use of a strong colour. Keeping all other text to a minimum, the remainder consisted of a link to the credits and help pages, copyright information and the author's name and contact information.

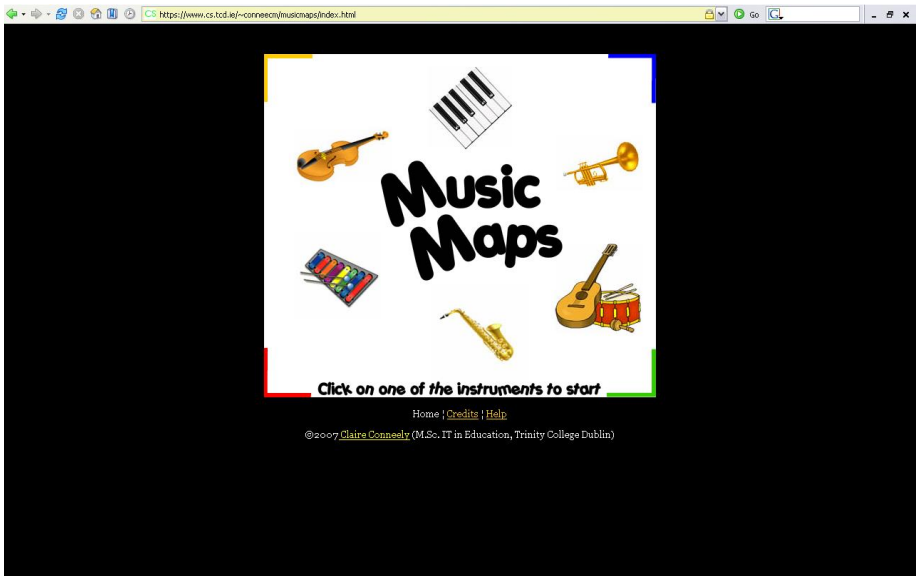

Figure 3.2 *MusicMaps* opening screen

3.3.2. 'Create a *MusicMap*' Screen

Uniformity and consistency were important considerations throughout the design of the artefact; hence the researcher applied the same design to the 'create a *MusicMap*' screen

for each of the six pieces. The only difference was in the map-making area for each piece of music, which depended upon the instrumentation involved. A list of the main instruments or group of instruments playing in each extract, along the left-hand side of the workspace, gave participants some basic direction in how to construct their maps. See Figures 3.3 and 3.4 for comparison between the workspace design for a piece of music with just one solo instrument and a piece with four different instruments.

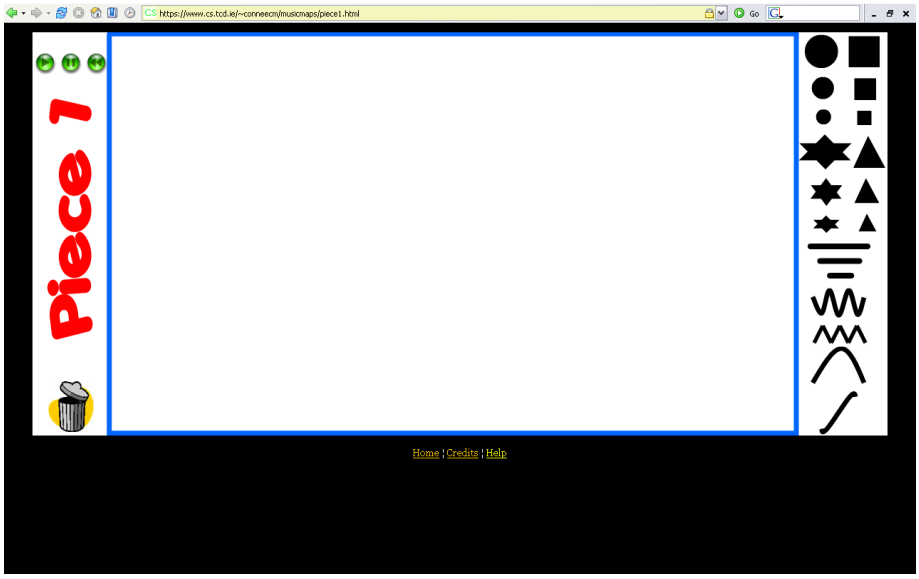

Figure 3.3 Piece 1 (one instrument)

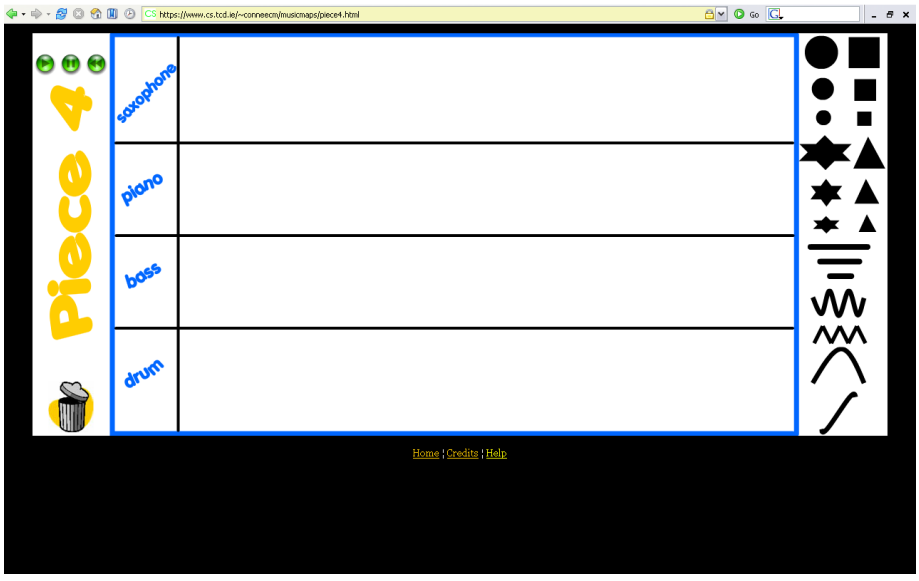

Figure 3.4 Piece 4 (four instruments)

Three buttons on the upper left-hand side of the screen provided users with the means of playing, pausing and rewinding the music. The reasons for allowing user control of the audio were twofold. Firstly, it was of utmost importance to the learning activity that participants were in control of their own construction process and could listen to the music in any manner they wished. It was also important that throughout the activity the researcher could observe their listening strategies and the manner in which they engaged with the activity.

Two key studies from the literature informed the decision to provide users with abstract shapes and lines, of various sizes, with which to create an on-screen representation of their perception of a piece of music. In the conclusion to their study, Tan and Kelly (2004) suggest that future research in the area should bear in mind that explicit directions about how to represent music may provide listeners with ideas that may not otherwise have occurred to them. Therefore, by providing some direction as to what representations to use, but not how to use them, it is possible that participants reach a higher level of engagement in the process of listening. Bamberger (1994) states that 'units of description' have certain qualities and constraints attached to them. Therefore participants' representations of their perception of the music will be greatly influenced by the 'units of description' available to them in the graphical interface.

As explained under the 'Technical Requirements' section above, ActionScript facilitates the duplication and rotation of movie clips. By double-clicking on a chosen shape/line, users can drag and drop it anywhere on the map area. Using the right and left keyboard arrows users can rotate shapes/lines positioned on the map (see Figure 3.5 for a sample created representation). A bin on the lower left-hand side of the screen provides users with the means of deleting graphical icons from their map if necessary.

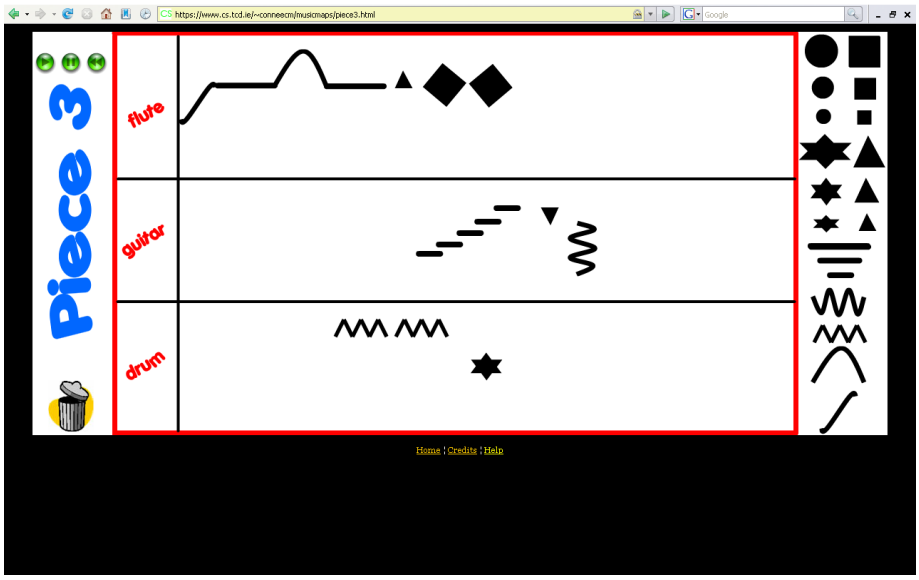

Figure 3.5 Sample music map of Piece 3

3.4. Summary

For the purposes of the current study, the researcher decided to make graphical icons available to the participants so that, in the course of decisions made and actions taken during the listening activities, participants would attribute individual and shared meanings to their chosen shapes and lines. Furthermore, such a design approach affords the opportunity to the researcher to examine associations between participants' units of description and their units of perception.

Having outlined the design of the *MusicMaps* graphical interface for the purposes of answering the research questions of the current study, there now follows a chapter on the methodology employed during the implementation of the artefact.

4. Methodology

4.1. Introduction

Having presented the design of the *Music Maps* interface in the previous chapter, this chapter outlines the qualitative research methodology employed during the research project. The chapter will discuss the conditions for the case study and present a profile of participants involved. A concluding section will summarise the methods employed to collect, code and analyse the data into themes in order to provide answers to the research question and sub-questions determined at the outset.

4.2. A Qualitative approach

The current study follows a methodology of qualitative research. One of the aims of qualitative research is to remain open to what a particular action, or set of actions under study, will reveal about participants' perceptions, understandings and views (Phelps, Sadoff, Warburton and Ferrara, 2005). Based on this principle, the aim of the current study is to employ qualitative methods in order to suggest possible answers to a set of research questions proposed at the outset.

Within the paradigm of qualitative methodology, this experimental research also qualifies as a case study. The purpose of case study observation is 'to probe deeply and analyse intensively the multifarious phenomena that constitute the life cycle of a unit with a view to establishing generalisations about the wider population to which that unit belongs' (Cohen, Manion and Morrison, 2000, p.106). The merit of applying case study methodology is that human systems have a wholeness or integrity to them, rather than being a loose connection of traits, necessitating in-depth investigation (Sturman, 1999 as cited in ibid). A case study is concerned with a rich and vivid description of events relevant to a subject and focuses on seeking to understand individual participants' perceptions of actions (Hitchcock & Hughes, 1995 as cited in ibid).

The two primary data-gathering tools for qualitative research are participant-observation and interview, both of which are marked by the central role of the researcher in data-gathering and data-analysing (Phelps et al., 2005). Other qualitative forms of data

include documents, such as a research journal or samples of participant's work, and audio-visual materials, such as digital video footage (Creswell, 2005).

4.3. Case Study Conditions

4.3.1. Participant profile

The participants in this study were eight boys, aged between 11 and 12 years. All of the participants currently attend a private boys' school in Dublin city centre and are in 6th Class. As part of their regular timetable, all participants receive one 40 minute, class-based, music lesson per week. The fact that some participants also attend private formal music lessons outside of school was not a factor in the selection process.

4.3.2. Parental permission

Before the implementation stage of the project, the researcher sent a letter (Appendix B) to the parents/guardians of each participant, detailing the nature of the research and requesting permission for their son to be involved. The letter requested permission to use a digital video recorder and offered copies of the video footage to the parents upon demand. The parents/guardians of each participant returned a signed consent form (Appendix C) before the investigation began.

4.3.3. Researcher profile

The author/researcher currently teaches music in both the primary and secondary sections of the school in which the study was conducted. Currently, the researcher is responsible for all aspects of music in the primary school, teaching 1st-6th classes on a weekly basis, conducting the choir and organising extra-curricular musical activities. Consequently, the researcher personally knew all of the participants involved in the project.

4.4. Implementation Stage 1

4.4.1. Pre-Activity

The first stage of the implementation took place over two days - 6th and 9th March 2007. During the experiment, all eight participants individually made a music map of Piece 1 and their choice of one other map from either Piece 2 or 4 (see Appendix D for table of completed pieces). As a result of varying abilities, listening strategies and creativity skills amongst the participants, there was no time limit set for each individual participant.

The researcher presented participants with the option of using earphones to maximise their hearing of the extracts. However, in order that the digital video recorder would capture all aspects of the experiment and yield rich data for the analysis process, the researcher asked participants not to use the earphones if it was possible to hear sufficiently without them.

Before beginning to use the digital video recorder, the researcher explained to participants that its purpose was to capture their work on the computer screen and any conversation that took place during and/or after the activity. The researcher emphasised that the camera would not capture the participants themselves.

4.4.2. Introducing the artefact and task

There was no fixed protocol for the introduction of the artefact to the participants. The researcher demonstrated the basic functionalities of the *Music Maps* interface (using the help button) and then presented the following task to participants: 'Construct a map of the journey of this piece of music as you listen to it'.

The researcher took care in the phrasing of questions and instructions so as not to directly imply or suggest how to approach the task of constructing the music map or what specific musical features to attend to. If there was any confusion or uncertainty about the task in hand, the researcher used the following questions (or similar) to scaffold the activity:

- What can you hear in the music?
- What is happening in the music?
- What can we do to help us remember everything that is happening in the music?

- If you had to use one of these shapes to show that melody/rhythm/instrument what one would you pick?

Once participants felt comfortable enough to continue building the music map, the researcher resorted to a changing observational role for the remainder of the activity. A changing observational role is where researchers adapt their role to the situation, permitting the inquirer to be subjectively involved in the setting if need be as well as to see the setting from an objective point of view (Creswell, 2005). This non-directive approach affords a variety of unscripted reactions and allows for insight into both children's processes and those of the teacher (Jennings, 2006).

4.4.3. Collection of data from Implementation Stage 1

As previously stated, no limitations were set on the time for participants to construct their maps. During each individual's session, the researcher recorded relevant observations and reflections using an observational protocol (Appendix F). This purpose of this form is to ensure an organised means for recording and keeping observational field notes (Creswell, 2005). A digital video camera, used throughout the entire implementation, captured each participant's approach, processes of work and progression through the listening activity task. As Sherin (2000) emphasises, it is crucial to capture a thorough account of the process of creating graphic representations so as to gain an insight into why participants make the representations they do, when they do.

After the participants had completed each music map, the researcher conducted an unstructured interview (see Interview Protocol, Appendix G) to draw information and explanations from them. During the interview, the researcher asked participants to talk about their map and to describe how it related to and represented what they had heard in the music. If any new ideas or approaches arose during the interview, the participants were encouraged to make additions and/or changes to their maps. The digital video camera recorded this conversation for later transcription and analysis.

To ensure triangulation of data, participants' completed maps were captured using the print screen function and saved as image files for later analysis.

4.4.4. Analysing the data from Implementation Stage 1

The purpose of the initial stage of implementation was twofold. Firstly, it afforded individuals the chance to become familiar with the *Music Maps* artefact. Secondly, it provided an opportunity to briefly analyse participants' created maps and processes of work in order to achieve a maximal variation sampling for group implementation stage. Maximal variation sampling is a purposeful sampling strategy in which the researcher samples individuals that differ on some characteristic (Creswell, 2005). For the group implementation stage of the project, the researcher arranged participants into pairs based on the level of detail in their created maps and on the category to which their map belonged. Appendix H displays the differing characteristics of group member's maps which gave rise to a maximal variation sampling for the group implementation stage.

4.5. Implementation Stage 2

The second stage of the implementation took place over three days - 23rd, 26th and 30th March 2007. For their first collaborative activity, each group made a music map of either Piece 1 or Piece 2, which they had already created individually. On the second and third days of implementation, the researcher instructed the groups to create a map of a piece of music of their choice, providing they had not already completed an individual representation of the piece (see Appendix E for table of completed pieces).

The conditions for the second stage of the implementation were exactly the same as the first, with the researcher assuming a changing observational role and employing the same methods of data collection, in the form of an observational protocol, digital video footage, an interview protocol and the participant's created maps to ensure triangulation of data. At the end of this stage of implementation, each group participated in a brief, unstructured interview (Appendix I).

4.6. Data Analysis

4.6.1. Preliminary Exploratory Analysis

The first step in data analysis is to explore the data by examining all of the information to obtain a general sense of it (Creswell, 2005). A preliminary exploratory analysis in

qualitative research consists of immersing oneself in the details of the data, writing memos of ideas/concepts and thinking about the organisation of the data (ibid). An initial examination of the digital video recordings afforded the researcher the opportunity to make some brief notes and any relevant additions to the observation protocol used in the implementation stages. A preliminary exploration of students' created maps also helped form an initial analysis of the data.

4.6.2. Transcription of video footage

Transcription of video footage was the next step in the data analysis process. On the second viewing of the video footage, the researcher made detailed transcriptions of dialogue and unstructured interviews that took place during the two stages of implementation. The researcher viewed the footage in Windows Movie Maker, which allowed the division of the video material into smaller clips. Any significant events from the implementation were bookmarked, to facilitate further viewings of the data, specifically for the later process of coding and organising the data into themes relevant to the research questions.

4.6.3. Coding and Theming

Describing and developing themes from the data consists of answering the major research questions and forming an in-depth understanding of the central phenomenon of the investigation (ibid, p. 265). In order to extract relevant codes from the data, the researcher firstly revised any initial memos and concepts written in the margins of observation protocols and transcriptions and then labelled large segments of text with key words and/or phrases. Appendix J contains sample extracts of transcription showing segments of text grouped into codes. Upon completing codes for the entire text, the researcher made a list of all code words. Aggregation of similar codes formed overall themes and categories of behaviour.

The following chapter will address the principle themes and categories of behaviour emerging from the data analysis.

5. Findings

5.1. Introduction

Having outlined in the previous chapter the research methodology of the *Music Maps* project, this chapter presents the main findings from an in-depth analysis of data collected from various sources.

The principle themes emerging from the data relate to participants' level of engagement with the music and their perception of musical features, their representative use of graphical icons and the role of the teacher in a graphically-mediated listening activity. The chapter will consider each theme firstly from the perspective of the individual implementation and then from the group perspective, so as to emphasise the effect of collaboration on individual performance. The role of the teacher will be considered separately.

5.2. Engagement with music

This section considers participants' engagement with music under the broad headings of method and motive. It firstly outlines several differences in the manner in which children engage with music in a technology-mediated listening activity. Secondly, this section addresses the reasons for an increase in participant's level of engagement with music during the group implementation stage.

5.2.1. Listening Method

5.2.1.1. Individual methods

Data analysis reveals a distinction between individual participants' methods of listening.

- **Single Listeners**: One single hearing
- **Multiple Listeners**: Several hearings

Analysis of participants' maps suggests that multiple listeners' representations are more detailed than single listeners (see Figure 5.1 and Figure 5.2 for comparison). The fact that multiple hearings of a piece of music can lead to a higher level of perception of musical features has important implications for the ways in which teachers should encourage children to engage in music listening.

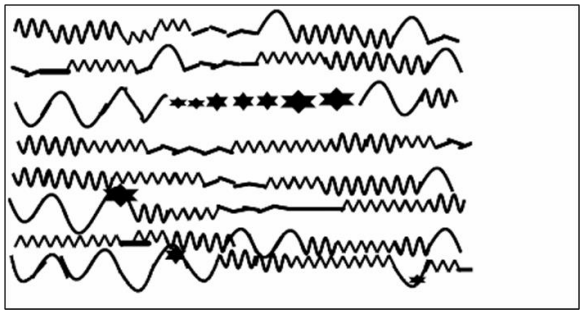

Figure 5.1 Multiple listener (*Participant 6: Piece 1*)

Figure 5.2 Single listener (*Participant 1: Piece 1*)

Within the category of multiple listeners, there is a further distinction between participants' method of listening.

- **Complete listeners**: Listen from start to finish
- **Fragmentary listeners**: Listen to brief sections

Analysis of participants' completed maps suggests that fragmentary listeners create organised, structured representations, whereas complete listeners' maps seem disordered in comparison (see Figure 5.3 and Figure 5.4).

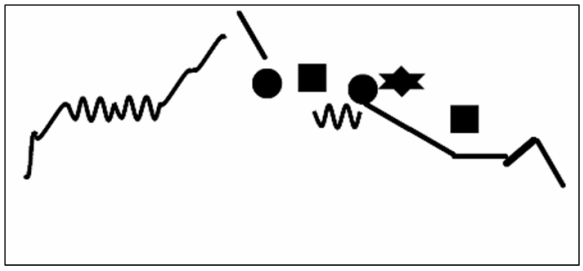

Figure 5.3 Fragmentary listener (*Participant 4: Piece 1*)

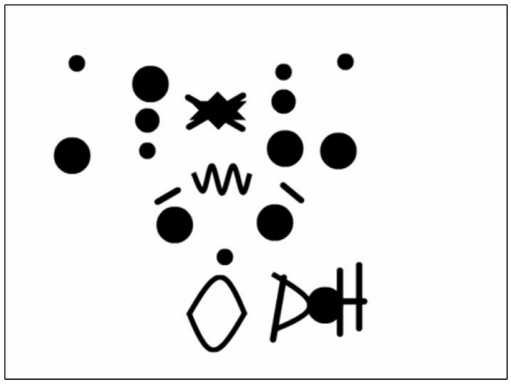

Figure 5.4 Complete listener (*Participant 2: Piece 1*)

These findings suggest that fragmentary, multiple hearings enable students to create a more accurate and structured representation of their perception. Furthermore, the data demonstrates that a graphical computer-based listening activity can facilitate teachers with an insight into children's methods of listening.

5.2.1.2. Group methods

Analysis of data from the collaborative implementation stage exposes a consistent group behaviour of multiple, fragmentary listeners. The following section outlines the reasons why group activity affected participants' levels of engagement with the music.

5.2.2. Listening Motive

A change in participants' level of engagement with music during the individual activities was largely due to teacher interventions. 'Role of the Teacher' addresses this finding in detail below.

Analysis of researcher observations and student dialogue transcripts from the group implementation stage reveals an overall increase in participants' level of engagement with the music. Findings indicate several reasons why participants engaged in a multiple, fragmentary method of listening to the music, such as in order to direct the task and to revise their work. The discussion chapter will address additional motives in greater detail.

5.3. Perception of musical features

There is a hierarchy of musical features perceived during a graphically-mediated music listening activity. Given that the design of the artefact to some extent imposed perception of instrumental sound and order of instrumental entries on participants, analysis focuses instead on perception of other musical features.

While all individual participants and groups did not attend to exactly similar musical features, melodic contour, pitch and volume are the three most perceptually salient features (see Appendix K). This section will address findings specific to each feature in detail.

5.3.1. Melodic contour

Participant's perception of melodic contour (the shape of a melody line) is evident in their completed maps and also in the transcripts of dialogue during and after the listening activity. For example, Participant 7 explains his choice of symbols to represent melodic contour:

Participant 7

'For the bits that went up-and-down, up-and-down I used these (*pointing to squiggle shapes*)… and the same for them (*pointing to other squiggle shapes*)… but that (*pointing to curved lines*) was when it went straight up and stayed there for a while and then came back down.'

Similarly, peer dialogue during Group 2's construction of their first map reveals a perception of melodic contour:

Group 2

Participant 4: It's kind of up-and-down isn't it?

Participant 2: Yeah […]

Participant 4: Maybe one of these to show up-down, up-down (*dragging a zig-zag shape onto the map*)

5.3.2. Pitch

Analysis of data indicates an overall prevalence of perception of pitch (high/low notes). Teacher questioning reveals that pitch is the feature most salient to Participant 4:

Teacher: Ok, so what's the first thing that strikes you about the music?

Participant 4: Well, it's playing high notes and then low notes…

Teacher questioning during the group implementation stage also reveals an acute perception of pitch (see Figure 5.5):

Group 2

Teacher: […] that looks very like the trumpet shape you had at the start…

Participant 2: Yeah

T: So does it mean the same thing?

P2: Well, the trumpet one starts from higher and goes to lower, but the string one goes from lower to higher

T: Ah, I see. Well done.

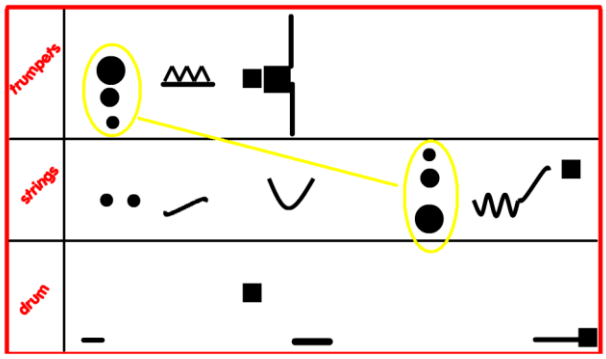

Figure 5.5 Representation of perception of pitch (*Group 2: Piece 2*)

5.3.3. Volume

Volume of musical sounds emerges as the third feature most perceptually salient to participants. Participant 8's explanation of his graphic representation exposes his perception of volume:

Teacher:	[…] Do they all play the same?
Participant 8:	No, these at the front would be louder, and the ones at the back wouldn't be as loud…

An extract from the transcript of student-teacher dialogue during the construction of Participant 5's second map indicates a perception of volume in relation to other instruments:

Teacher:	And what about the drum?
Participant 5:	I don't think it's as loud as the strings…

Participant 1 and participant 3 did not demonstrate a perception of volume, either in their graphic representations or in dialogue with the teacher, during the individual implementation stage. However peer-dialogue from the group implementation stage indicates that both individuals developed an increased perception of this musical feature.

Data analysis reveals that a graphical interface provides participants with a variety of means of creating personal representations of inner perceptions of music. The following section addresses this finding in detail.

5.4. Using graphical icons to represent music perception

Four main categories of constructed maps emerged from analysis of the data. Considering the researcher included arbitrary shapes and lines in the design of the interface with the intention of facilitating the creation of symbolic graphic representations, the emergence of differing map categories was a surprising finding (see Appendix L).

This section will present findings in relation to the various meanings attached to graphical icons and the consistent use of invented representations throughout the activity.

5.4.1. Meaning attached to graphical icons

Data analysis indicates that participants attribute meaning to graphical icons based on symbol shape, symbol size and symbol placement. The following section outlines the findings in relation to each category of representation.

5.4.1.1. Symbol Shape

Findings indicate that symbol shapes present a range of possible means of representing musical features. Both individual and group participants used symbol shape to represent melodic contour, tempo, volume, variation and repetition in melody/rhythm and the order of instrumental entries. Some participants relied on symbol shape to represent combinations of musical features, such as Participant 4's representation of pitch and tempo:

Participant 4:	Well, it's playing high notes and then low notes, all very fast
Teacher:	Right, so you've got to show fast and high and low notes in your map…
Participant 4:	So, maybe one of these (*pointing to a squiggle shape*)?

During the construction of their first map, the members of Group 3 negotiate which shape best represents their perception of melodic contour and tempo:

Group 3	
Participant 7:	Or else, we could do one of these (*pointing to curve shapes*) - because it goes up and then it goes back down, and then it goes quick. So, maybe will we dump that one (*P3's star shape*)?
Participant 3:	Yeah, ok. (*P7 plays the music again*). Yeah, I think that's better there.

5.4.1.2. Symbol size

Analysis of data suggests that participants used symbol size primarily to represent the volume of musical sounds. Participant 7 explains that '*the triangles here – the smaller one means less loud*' and Participant 4 describes how '*the drum and the trumpets start off… they start off small. And then they get bigger – so I'm going to use bigger circles*'.

Some participants also used symbol size to represent pitch. Group 1 made use of different line sizes to represent their perceived high and low sounds. Participant 2 made use of symbol size to construct a combined representation of volume and pitch:

Teacher:	Why did you pick the three lines?
Participant 2:	To show the volume… small, medium and big. So it's a little bit quiet, then it goes up and it gets a bit louder, then up again and loudest.

5.4.1.3. Symbol placement

Most participants considered the placement of symbols within their maps as representative of the order of instrumental sounds. There was one occurrence of using symbol placement to represent volume of the music and order of instrumental entries. This finding is surprising in that it contradicts a common understanding of how children assign meaning to notation systems (for example, time/sound generally perceived along the x-axis, or horizontally). Participant 8 represents the volume and order of instrumental sounds along the y-axis, or vertically (Figure 5.6).

Teacher:	So tell me about the smaller trumpet players
Participant 8:	Yeah, they're going further back
T:	Ok. And does that show us anything about the trumpet tune? Do they all play the same?
P8:	No, these at the front would be louder, and the ones at the back wouldn't be as loud…

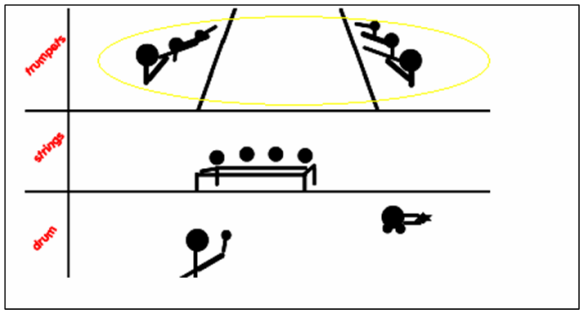

Figure 5.6 Symbol placement to represent volume & order of instruments (*Participant 8: Piece 2*)

5.4.2. Consistent use of graphical representations

Data analysis reveals that most individual and group participants used their invented graphic representations consistently within maps and also across maps of different pieces of music. Most participants used the same symbol within a map to represent repetition of melody/rhythm. Other participants make consistent use of symbols within maps to represent the same musical feature. For example, Group 3 discussed their representation of volume in relation to one instrument and then decided to apply it to other instruments perceived at the same level of volume.

However, not all participants demonstrated a consistent application of symbols within their maps to represent the same musical feature, as highlighted in dialogue between the researcher and Participant 1, post-construction of his first music map:

Teacher:	Ok, great. And this squiggle here at the end…?
Participant 1:	It's sort of the same as the one at the start.
T:	Is it exactly the same?
P1:	Well, yeah, I think so.
T:	So is there any reason why you picked a different squiggle though?
P1:	No, no reason.
T:	Ok.

Several groups used their invented representations consistently across different maps. For example, Group 1 invented a representation for repetition during the construction of their second map and explicitly decided to re-use it in their third map.

Data analysis of peer-dialogue during the group implementation stage of the project indicates that the collaborative approach to attributing meaning to graphical icons not only leads to the creation of a shared representation but also to a shared understanding and perception of the musical sounds. The discussion chapter considers this finding in greater depth.

5.5. Role of the Teacher

An in-depth analysis of data from the individual and group implementation stages of the project reveals findings specific to teacher interventions during a graphically-mediated music listening activity. The emergent categories of behaviour in relation to teacher interventions are time, type, reason and response.

5.5.1. Time of intervention

During the individual implementation, teacher intervention took place predominantly post-activity. In some cases, it was necessary to intervene at the start of the activity in order to assist participants who were uncertain about the task. For the most part however, participants worked by themselves and explained their maps during the post-construction interview.

During the group implementation stage, teacher intervention took place primarily during the map-making activity. Given the high level of teacher involvement during the collaborative construction of the music maps, there was never a great need to conduct the post-construction unstructured interview, as discussion of the group's perceptions and representations flowed continuously throughout the activity.

5.5.2. Type of intervention

Findings indicate that, during a graphically-mediated music listening activity, there are two prominent types of teacher intervention.

- **Question**

  Example: '*So if you had to show that it ended loud, what [shape] would you pick*?'

- **Suggestion**

  Example: '*So keep all the symbols you have, let's just try to organise it to follow the journey of the music more clearly…*'

Further data analysis reveals different categories of questions.

- **Direct/closed questions**

  Example: '*Do all the instruments start at the same time*?'

- **Suggestive/open questions**

  Example: '*So is there any easier way to show that [on your map], instead of having to drag out all those shapes again and again*?'

The following section presents some possible reasons for the researcher's use of the different type of interventions.

5.5.3. Reason for intervention

Analysis of the transcripts of student-teacher and peer dialogue reveals several reasons for teacher intervention, both during and after the map-making activity. Suggestions at the

beginning of the activity served to scaffold participants' initial approach and to direct their listening. Findings indicate the use of both suggestions and questions during the listening activity in order to develop participants' perception skills. Direct questions encouraged students to listen for specific musical features and assisted students in becoming aware of their own perception.

In relation to the use of graphic representations, direct and suggestive questions served to verify the meaning of participants' representation and to develop ideas about creating a representation of their perception of musical sounds. Other direct questions assisted in a more accurate representation of participants' perception.

Specific to the group implementation stage of the project, teacher interventions were necessary to ensure equal sharing of tasks and equal participation between group members. Teacher questions and suggestions were also required to bridge the gaps in student dialogue, particularly to help participants understand the meaning of another's perception and/or representation.

Group 1	
Teacher:	So what's the piano doing?
Participant 1:	It sort of sounded disconnected and then down… it keeps doing disconnected notes and then goes down
T:	Oh right…
Participant 8:	So it's all disconnected?
P1:	Yeah, I think so
P8:	Ok, I see what you're doing now

5.5.4. Response to intervention

This section outlines the categories of student responses to teacher interventions. The discussion chapter will address these finding in relation to the implications for teaching music listening skills.

5.5.4.1. Verbal response

Analysis of transcripts of student-teacher and peer dialogue reveals that students often respond to interventions with a direct question to the teacher, to verify their perception. Teacher intervention also often results in students responding with peer-questioning, as demonstrated in the following extracts of conversation:

Group 3

Teacher:	Well, what just happened there in the music?
Participant 6:	It went kind of a little bit quiet again, so which one do you want to use?
Participant 5:	Yeah, that one.
P6:	And then it got bigger again… so this one (*adds a bigger squiggle*)?

P5:	Oh, it goes back there…
T:	What does it go back to?
P5:	It goes back like the start
P6:	Does it? (*A plays the music again*) Yeah it has!

5.5.4.2. Musical response

Analysis of participant behaviour during a graphically-mediated listening activity indicates a number of 'musical' responses to teacher interventions. Some participants demonstrated their perception of musical features by singing, clapping, tapping or a combination. In response to a direct question, one participant demonstrated his perception of melodic contour by singing and also miming body movements of playing the piano:

Group 3

Teacher:	Right, what happened there at the end?
Participant 7:	It sort of went hmmmmm hmmmmmm (*singing*)
Participant 3:	It went up and back down, or something
P7:	Yeah, if you were playing it on piano it'd be like this (*mimes playing the piano*)

Data analysis reveals a significant number of individual and group participants that responded to teacher interventions by re-listening to the music, often listening *for* a specific musical feature.

Teacher:	And do they [the drums] come back in later then?
Participant 4:	Yeah. I'll just listen to make sure. (*Listens to the music again*) Yeah. And the strings come in last…

These musical responses are testimony to the fact that a graphically-mediated collaborative music listening activity can promote active, musical involvement among participants.

5.5.4.3. Interface Action response

A significant number of participants responded to teacher interventions with an 'action' within their map, generally in order to create a more accurate representation of their perception of the musical sounds. Direct questions tended to result in participants making alterations to their map, whereas suggestive questions usually lead students to make additions to their maps.

5.6. Summary

Having outlined the principle findings above in relation to participants' engagement with music and their perception of musical features, their representative use of graphical icons and the role of the teacher in a graphically-mediated listening activity, the following chapter will focus on some of these findings for in-depth discussion, with particular emphasis on data collected from the group implementation stage.

6. Discussion

6.1. Introduction

The previous chapter dealt with an initial description of the project's findings. This chapter now addresses the overall meaning of these findings in light of the relevant literature and the research questions determined at the outset. Given that the primary aim of the study is to investigate the use of a graphical computer interface as a facilitator of collaborative interaction during a music listening activity, the discussion will focus on findings from the group implementation stage of the project.

This chapter will firstly address the effect of collaborative activity on individual levels of engagement with musical sounds. It will then consider the effect of a dialogue-based group activity on the development of music perception. Following this is a discussion on the merits of collaboratively creating graphic representations. The chapter will conclude by outlining significant implications for the teaching and learning of music listening skills.

6.2. The effect of collaborative activity on listening patterns

Findings indicate an overall heightened level of engagement with music during a collaborative listening activity. Collaboration results in a change in the behaviour of single, complete listeners. For example, researcher observations recorded that Participant 1 "listened to the entire piece once and then worked on his maps in silence". However, as part of a group, there was an increase in this participant's level of engagement with the music as he developed a multiple, fragmentary method of listening to the music. This offers a solution to the question of whether participation in group listening activities affects children with diverse patterns of individual listening (Sims & Nolker, 2005).

When engaged in a collaborative graphically-mediated listening activity, children adopt a multiple, fragmentary method of listening. Analysis of peer-dialogue gives an insight into the reasons why groups adopt this particular listening method. For example, peer questioning leads participants to play the music several times to verify their initial perceptions.

Group 2

Participant 4: It starts off with the drums first…

Participant 2: Oh yeah

P4: The drums, they start off low so maybe…

P2: Yeah, and they stay the same pace all the time

P4: Let's listen again (*P4 plays the music again*) Yeah, they stay low so…(*choosing a line shape, P2 points out the smallest one*) put it down here, 'cos they're low. (*P4 plays the music again and they talk as the music is playing*)

Also, there are increased levels of engagement with the music in order to explain constructed representations of specific musical features.

Group 4

Participant 6: Do you want to listen again?

Participant 5: Yeah

Teacher: Yeah, that might be a good idea.

(*P6 plays the music again, following the music with the mouse pointer to show P5*)

Some group members direct their peers to re-listen to the music in order to understand their perception of a particular musical feature, often demonstrating their perception first by singing and/or clapping.

The above quotes indicate that involvement in a graphically-mediated listening activity encourages participants to re-engage with a piece of music in order to listen *for* a specific feature or sound. Learners progress from a passive hearing stage, through to an active, listening *for* stage (*Degrees of Audition*, Elliot, 1995, p.80). The design of the *Music Maps* interface encourages participants to become multiple listeners and actively engages students in a generative process of making meaning in musical sounds (Bamberger, 1994). Furthermore, the graphical interface facilitates a collaborative approach to music listening which promotes and enables a heightened level of active musical involvement among all participants.

6.3. The effect of group dialogue on the development of music perception

Music Maps facilitates a dialogue-based group activity, in which participants not only represent on-screen, but also orally express their acute perceptions of musical features. A graphically-mediated collaborative listening activity encourages students to describe and critically discuss musical sounds. Questions and suggestions in relation to individual perceptions during group activity facilitate peer mentoring in listening *for* specific features.

Group 2

Participant 4:	Yeah. Did you hear them [the strings] stop? Do you think they stopped?
Participant 2:	Em…
P4:	You know, halfway through […] That's strings there…
P2:	Yeah, they stopped
P4:	Will we put a smaller square?
P2:	Oh no, hang on, they're still playing!
P4:	Yeah!
P2:	They didn't stop at all…

A graphically-meditated, dialogue-based collaborative listening activity provides a framework in which students can more fully describe and account for their individually tacit and intuitive perceptions of music, deemed necessary in the literature relating to the development of perception (Bamberger, 2003). Participation in a graphically-mediated group activity promotes 'positive, constructive interactions among students' (Holloway, 2004, p. 90) and a positive effect on the development of music perception.

6.4. Collaborative invention of graphic representations

Data collected from interviews conducted at the end of the group implementation stage of the project reveals a positive attitude among all participants towards the collaborative approach to creating a graphic representation of a piece of music (see Appendix I).

Findings also indicate that collaboration results in participants adopting new methods of representation. For example, Participant 8, who created pictorial maps when working

alone, did not adopt similar principles when working collaboratively. Responses during the unstructured interview suggest that peer-dialogue and peer-mentoring lead to an awareness of alternative modes of representing perception of musical features (see interview with Group 1 in Appendix I). Perhaps this answers the question of whether there is a relationship between individual performances during group activities compared to solitary activities (Sims & Nolker, 2005).

A graphically-mediated group listening activity facilitates the exchange of ideas among students regarding the means of externalising their inner perceptions of musical sounds. This results in different patterns arising between individual and collaborative methods of work. It also facilitates peer mentoring in the generation of ideas for creating graphic representations.

Interview with Group 4

Teacher:	Do you think you get more ideas working with another person?
Participant 5:	Yeah!
Participant 6:	Yeah definitely… because I kept using waves on my first one and then P5, he obviously liked using the other shapes
T:	Right so you got ideas from what P5 suggested then?
P6:	Yeah
T:	And did you get ideas from P6?
P5:	Yeah, I think so

Collaboratively creating graphic representations not only leads to the creation of a shared representation but also to a shared understanding and perception of musical sounds. For example, while constructing their first map, Group 4 discussed their representation of volume, leading to a shared meaning attached to a specific shape and also resulting in a shared, more accurate perception of the volume of the music.

These findings suggest that a graphical interface provides a medium for communication during a collaborative activity, whereby students can intuitively represent and demonstrate personal perceptions of musical sounds. A graphically-mediated demonstration of perception during a group activity leads to an awareness of individual hearing and the development of meta-cognition, necessary for the ability to choose selectively and knowingly about possible hearings (Bamberger, 1994, 2004). Moreover, the

collaborative invention of graphic representations facilitates the development of a shared perception and understanding of musical sounds.

6.5. Implications for teaching

Teachers have an important role to play in the development of children's critical listening skills, defined as a combination of perception and critical thinking. A graphical interface affords teachers the opportunity to promote dialogue about music sounds *through* students' processes of graphically representing their inner perceptions. During a graphically-mediated listening activity, student-teacher dialogue introduces learners to alternative modes of representation, which can lead to an increased awareness of hearings. Individuals need guidance in becoming aware of their own hearings, to recognise to which aspects they are giving priority and to develop the ability to choose selectively and knowingly about hearings (Bamberger, 1994, 2005).

Findings indicate that graphically-mediated collaborative listening facilitates active involvement among peers, which in turn promotes higher levels of student-teacher interaction. The *MusicMaps* interface breaks the barriers of conventional music notation and facilitates students with a more intuitive means of communicating and representing their perception of musical sounds. Teacher involvement in a graphically-mediated listening activity is essential in order to develop children's ability to represent and perceive pieces of music in their entirety. Similarly, teacher involvement assists students in viewing their created representations as accurate reflections of their hearing of specific musical features.

It is essential that music teaching and learning is structured in a way that reflects and develops the 'multidimensional form of thinking and knowing' (Elliot, 1995, p.101) that is music listening. A collaborative implementation of a graphically-mediated listening activity presents researchers with an opportunity to focus on interactions (both teacher interventions and student responses) in order to gain an insight into the underlying cognitive processes of this most complex musical activity. An understanding of children's listening strategies serves as the essential starting point from which teachers can develop the skill and encourage students to listen in new ways.

The final chapter presents the main conclusions of this study and outlines some suggestions for future research in the area.

7. Conclusion

7.1. Summary

The results of the current study suggest that engaging in a graphically-mediated collaborative listening activity engenders the development of critical listening skills in children. A graphically-mediated collaborative approach to listening promotes active, musical involvement and interactive dialogue among learners, essential for the development of critical listening skills.

Findings reveal that melodic contour, pitch and volume are the three most salient musical features perceived by children during a graphically-mediated listening activity. A collaborative approach leads to increased levels of engagement with music and a greater occurrence of perception of specific musical features among participants. A graphical interface such as *Music Maps* provides a medium for communication during a collaborative activity, whereby students can discuss, represent and demonstrate personal perceptions of musical sounds.

Findings also yield significant insights into children's perception from the ways in which they collaboratively assign meaning to graphical icons. Children rely on shape, size and placement of graphic representations to make meaning of musical sounds. Furthermore, the process of collaboratively assigning meaning to graphic representations facilitates the development of a shared perception and understanding of musical sounds.

Results of the study reveal that teachers have an important role to play in engendering the development of critical listening skills during a graphically-mediated collaborative activity. A graphical interface affords teachers the opportunity to promote dialogue about musical sounds *through* the collaborative approach to graphically representing inner perceptions. The findings offer some alternative suggestions as to how teachers can attempt to firstly understand and subsequently develop students' critical listening skills.

7.2. Recommendations for future research

There are a variety of options for future work in order to verify and expand on the findings of the current study. From a technical perspective, the design of *Music Maps* could

be further developed as an internet-enabled, computer-mediated collaborative learning experience. Such an interface could facilitate the collaborative creation of music maps by students in different locations, working together through a web interface and communicating via a built-in instant messaging system. Given that findings of the current study emphasise the importance of face-to-face peer and teacher dialogue during a graphically-mediated collaborative listening activity in engendering the development of critical listening skills, it would be interesting to investigate and compare the effects of such design developments.

Considering that the criteria for selection of participants did not take musical training into account, for future research might consider comparing a group of musically trained participants with a selection of non-music students. Possible research questions arising from such a comparative study could address the role of formal music training in shaping and influencing children's critical listening skills.

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Appendix A: Sources for Musical Extracts

Piece 1:

Chopin, F., Étude in G flat major, Op. 10, no. 5, 'Black Key' [Recorded by Vladimir Ashkenazy]. On *Chopin Favourite Piano Works* [CD]. Decca (1995)

Piece 2:

Britten, B., The Young Person's Guide to the Orchestra – Trumpets [Recorded by the Wurttemberg Chamber Orchestra, conductor Jorg Faerber]. On *Prokofiev: Peter and the Wolf; Britten, Saint-Saëns* [CD]. Vox Allegretto (2002)

Piece 3:

Piazzolla, A., Histoire du Tango: Bordel 1900 [Recorded by Marc Grauwels, Yves Storms & Frank Michiels]. On *Piazzolla… Shankar* [CD]. Syrinx Record (1991)

Piece 4:

Brubeck, D., Take Five [Recorded by the Dave Brubeck Quartet]. On *Ken Burns Jazz: The Story Of America's Music* [CD]. Legacy Recordings (2000)

Piece 5:

Turner, A., A Certain Romance [Recorded by The Arctic Monkeys]. On *Whatever People Say I Am, That's What I'm Not* CD]. Domino Records Ltd. (2006)

Piece 6:

Mussorgsky, M. P., Night on the Bare Mountain [Recorded by the Slovak Philharmonic Orchestra, conductor Daniel Nazareth]. On *Mussorgsky / Borodin* [CD]. Naxos (1987)

Appendix B: Letter seeking parental permission

[School address]

14th February 2007

Dear Parent/Guardian,

I am currently studying part-time in Trinity College for a Masters Degree in IT in Education. As part of the final year requirements, I am undertaking a research project in the area of using technology in music teaching and learning. With your permission, I would like your son to partake in this research. Below is a brief outline of the project to help you decide whether you wish your son to participate in the study.

All the participants involved will use a computer application (which I have developed) to complete a series of music listening activities. They will then take part in a group discussion and further group work using the application. The participants will be video-taped throughout the activities and all the video footage will be transcribed for the purposes of collecting data for the project.

The participants' real names **will not** be used in the project. If you would like copies of the transcript or the video footage I would be happy to oblige. If you have any questions relating to the project, please do not hesitate to contact me.

If you are happy for your son to partake in this research, please sign the consent form attached and return it to either myself or [class teacher's name] at your earliest convenience.

Many thanks,

Ms. Claire Conneely

Music Teacher

Appendix C: Consent Form

I _____ give permission to _____

(Parent / Guardian) **(Child's name)**

to take part in a music listening activity using computers for the purposes of a research project to be carried out by Claire Conneely of Trinity College, Dublin.

I understand that the activity will be video-taped solely for the purposes of collecting data for the same research project.

Signed: **Date:**

_____ _____

Appendix D: Individual maps completed

Implementation Stage 1: Individual Listening Activity

PARTICIPANT	MAPS COMPLETED	
1	Piece 1	Piece 2
2	Piece 1	Piece 2
3	Piece 1	Piece 4
4	Piece 1	Piece 2
5	Piece 1	Piece 2
6	Piece 1	Piece 2
7	Piece 1	Piece 4
8	Piece 1	Piece 2

Appendix E: Group maps completed

Implementation Stage 2: Collaborative Listening Activity

PARTICIPANTS	MAPS COMPLETED		
Group 1 (Participants 1 & 8)	Piece 2	Piece 4	Piece 3
Group 2 (Participants 2 & 4)	Piece 2	Piece 4	Piece 6
Group 3 (Participants 3 & 7)	Piece 1	Piece 5	Piece 6
Group 4 (Participants 5 & 6)	Piece 1	Piece 4	Piece 5

Appendix F: Observation Protocol

Participant's name: _____

Observer's name: _____

Role of Observer: _____

Descriptive Notes	Reflective Notes

Appendix G: Post-construction Interview Protocol

1. Tell me about the map you have made.
2. Can you explain to me what your map shows about the music?
3. Is there any reason why you used this shape here?
4. Is there any reason why each instrument is represented by a different shape? / Is there any reason why all the instruments are represented by the same shape?
5. Is there any reason why you used a bigger / smaller shape?
6. Is there any reason why you rotated this shape?
7. Does this shape mean the same thing when you use it with a different instrument?
8. Does this shape mean the same thing each time you use it?
9. Does your map make sense to you?
10. Can you follow your map as you listen to the music?

---

11. Did you find it easier working on the second / third etc. map?
12. If so / if not, why?
13. Do you think you did anything differently the second / third etc. time that you mightn't have done the first time?
14. If so / if not, tell me why.

Appendix H: Differing categories of individual maps

Differing characteristics of participant's maps from Implementation Stage 1

Group Members	Level of detail	Category of Map
Group 1:		
Participant 1	Medium	Symbolic
Participant 8	Low-medium	Pictorial
Group 2:		
Participant 2	Medium	Pictorial - symbolic
Participant 4	Medium-High	Symbolic
Group 3:		
Participant 3	Low	Textual - Symbolic
Participant 7	Medium-High	Symbolic
Group 4:		
Participant 5	Low	Symbolic
Participant 6	High	Symbolic

Appendix I: Post-activity Group Interviews

Group 1 (Participants 1 & 8)

T: So, now that you've made three maps together and two by yourselves, which did you prefer – working by yourselves or together?
P8: I think together
P1: Yeah
T: Do you know why?
P8: Just easier
P1: Em, some-one else's ideas sort of helps you get a better picture of it
T: So did you get more ideas when you were working with P8 then?
P1: Yeah
T: Ok, can you remember any time that there was something P8 did that gave you a new idea?
P1: Em….
T: No? That's ok. It was just better working together was it?
P1: Well, yeah
T: And what about you P8, was there anything P1 did that helped you to think more about the music?
P8: Yeah, I actually noticed when I did the maps on my own I had a really different perspective of it – I actually drew pictures.
T: That's right, yeah
P8: And then P1 started it like this… so I started doing it like that
T: Well, so how come you changed and you didn't do any pictures this time?
P8: Em….well, I just thought that was more realistic, so you know…
T: Well, when you did your pictures you did manage to capture quite a lot of what the music was about…
P8: Yeah, but I just think this way showed more
T: Ok, good. And so after doing three maps together, was this last one easier than the rest?
P8&P1: Yeah
P8: That one was the easiest
T: And do you think it was because the piece was easy or because you were used doing the maps?
P8: I think we were used to it
P1: Yeah
T: 'Cos that was a tricky enough piece wasn't it?
P8&P1: Yeah
T: Ok, well done. Great work

Group 2 (Participants 2 & 4)

T: So, now that you've made three maps together and two by yourselves, which did you prefer – working by yourselves or together?
P2: It was fun together
P4: Yeah, a little bit better together
T: More fun?
P2&P4: Yeah
T: And what about ideas to make the map… was it easier when you were working with another person?
P2: Yeah 'cos we had loads of our own ideas
P4: Yeah, we had
T: So, P2, did you learn anything new from P4?
P2: Yeah
T: And same for you P4?
P4: Yeah, same
T: Do you think you did different things in your own map than when you were working with P2?
P4: Eh, yeah a lot different
P2: Yeah I remembered my own maps
T: Yeah, and you were able to use some of your own ideas weren't you P2, like your 'doh' word?
P2: Yeah!
T: And so after doing three maps together, was this last one easier than the rest?
P2: Yeah
P4: Probably… well no, the last one was probably the easiest
P2: Yeah the last one was easier
T: Ok, so why was this one harder then?
P2: Because there were more instruments
P4: Yeah a lot of instruments
T: Right, ok. But do you think if you'd started with this one you mightn't have been able to do it as good?
P2: Yeah… well actually…
P2: If I was on my own, I wouldn't have been able to do it that good
P4: Yeah, me neither
T: Right so because you were working together, it was easier?
P4&P2: Yeah
T: Ok, well done.

Group 3 (Participants 3 & 7)

T: So you were much faster completing your map today… how do you feel after making three maps together?
P7: Good
P3: Yeah
T: Did it get easier each time?
P7: Yeah it gets easier
P3: Yeah, definitely
P7: Because you kind of get to understand how the other person thinks
T: And did you think this piece was any harder than the others?
P7&P3: Yeah!
T: So are you glad it was the last one?
P7&P3: Yeah!
T: Do you think you would've been able to do it as good if you had started with this one?
P7: No,
P3: I don't think so, no, because we got experience doing the easier ones
P7: And we knew how to approach that one
P3: Yeah
T: Right. So did you prefer working by yourselves or together?
P7: Together, probably…
P3: It was easier together…
T: Why was it easier P3?
P3: Because you didn't just get your ideas…
P7: Yeah different ideas and then you combine them
T: Right so, when P7 came up with something did that help you to come up with ideas P3?
P3: Yeah
P7: Yeah same for me… like when P3 said that… (*pointing to a set of shapes on the map*)
T: Ok, very good, well done.

Group 4 (Participants 5 & 6)

T: So, now that you've made three maps together and two by yourselves, which did you prefer – working by yourselves or together?
P6: Well I think we might enjoy working together more
P5: Yeah together
P6: But I suppose there's aspects about working together compared to by ourselves – like I kind of hog the mouse a bit and I wouldn't say P5 really liked that!
P5: I didn't mind…I like working together
P6: And it's pretty fun!
T: Do you think you get more ideas working with another person?
P5: Yeah!
P6: Yeah definitely… because I kept using waves on my first one and then P5, he obviously liked using the other shapes
T: Right so you got ideas from what P5 suggested then?
P6: Yeah
T: And did you get ideas from P6?
P5: Yeah, I think so
T: Ok, good. And so after doing three maps together, was this last one easier than the rest?
P6: I think the second one was the hardest and this one was slightly easier…
T: Do you think that's because you were used to making the maps?
P6: I think it's because we were able to figure out what it is… in the music
P5: Yeah I think this one was the easiest
T: Because you feel like you're an expert map-maker by now?!
P5: Yeah definitely
P6: Yeah, me too

Appendix J: Sample extracts of coding/theming

Complete transcripts of both stages of implementation are available in the data folder on the CD that accompanies this paper

Codes		Themes
	Participant 4 **(T = Teacher)**	
Teacher question	**<u>Map 1</u> (Piece 1)** T: [Ok, so what's the first thing that strikes you about the music?]	Teacher intervention
Perception of pitch & tempo	P4: [Well, it's playing high notes and then low notes, all very fast]	
Teacher direction	T: Right, so [you've got to show fast and high and low notes in your map…]	
Seeks verification from teacher	P4: So, [maybe one of these] (*pointing to a squiggle shape*)?	
Perception of volume	T: Yeah, that looks good	Perception of most salient features
	P4: It [gets a lot softer then]… so maybe I could show the music going down… (*continues to work by himself for a while*)]	
Now able to work by himself	T: Ok, so will you explain to me what you've done so far?	
Explanation of perception of tempo & pitch	P4: Well, at the start [it's going fast and then it kind of slows down and it gets faster. Then it gets really high again. And then it goes back to the same in the middle – it's just sort of normal – and then it slowed right down and went really low.]	Perceptions explained via dialogue & graphic representations
Teacher direction	T: Ok, great. [Let's listen to the music again to see if there's anything else you might add.]	
Perceives & represents volume	P4: (*Plays the piece again and pauses*) It's [going kind of soft and hard, soft and hard here in the middle – so I'll use a circle and a square.]	
	T: And it's switching between the two of those, is it?	Meaning attached to symbol shape
Different sound = new shape	P4: Yeah, soft and hard, then soft and hard again. [Then there's something a little bit different after, so I'll use a	

Teacher guidance and direction of activity Further hearings = revision of work Additions / changes made to map Shape = represents perception of pitch Teacher direction & guidance	new shape.] (*Listens to the music again*) At the end, it goes kind of hard again T: Right, [so what did you use to show that before? P4: A square… (*adds a square to the end of his map*) T: Maybe we'll have one last listen, just so I can definitely follow your map] P4: Ok yeah. (*Plays the piece again and pauses*) [Before it gets to the soft-hard bit in the middle, it kind of goes down a little bit] T: Ok, so you need to show that? P4: [Maybe a line coming down (*adds a line to his map and continues to listen*) Oh, at the end, actually, it goes up a little bit first and then straight down… I'll change that] (*adds two lines to the end of his map*) T: So, [do you reckon you need a few listens before you can get everything that's happening in the music] P4: Yeah definitely.	Results of teacher intervention
Size = represents perception of volume Perception of contour & pitch Teacher intervention results in re-listening Perceives new sound Volume, tempo &	**<u>Map 2</u> (Piece 2)** P4: [The drum and the trumpets start off… they start off small. And then they get bigger – so I'm going to use bigger circles] T: Very good. P4: Then they both come [down a little bit. And when the strings come in, they start off slow.] T: Oh right, so [they're not in at the start of the piece then? P4: Eh, no… a little bit later T: Yeah, good. P4: (*Listens to the music again*) Actually, they are in at the start…] T: The strings? P4: Yeah, I can hear them now. T: Are they playing very softly? P4: Yeah, [they're hard to hear. Then,	Meaning attached to symbol size Effects of teacher intervention Perception of most salient features

contour		when they all slow down, they kind of stay there for a few seconds and then they all went back up again.]	
	T:	[Just the strings?	
Distinguishes between different instruments	P4:	No, all of them.]	
	T:	Oh, right. Great.	
	P4:	They go up to sort of normal, then they stop for a second and then [they start off slow again. I can hear the drum and the trumpet at the end… they keep going up and then they stop.]	
Tempo & pitch			
	T:	Yeah, very good. [Let's take one last listen to make sure you've got everything]	
Teacher direction			Significance of teacher intervention - student response
	P4:	(*Listens to the music again and pauses*) [Actually, there's only the trumpet and the strings along here… do you think the drum would just stop? (*Pointing to middle of map*)	
New perception. Asks teacher for verification			
	T:	Maybe they do…maybe they just drop out for a little bit]	
Change in map	P4:	[Ok, so I'll take this shape out…]	
	T:	[And do they come back in later then?	
Response to teacher question = another listen	P4:	Yeah. I'll just listen to make sure. (*Listens to the music again*)] Yeah. [And the strings come in last… after the drum and the trumpets – they come in first – and a few seconds later the strings come in.]	
Order of instrumental entries			
	T:	Ok, [so how could you show that in your map?	
Teacher guidance	P4:	Well, I could put this (*small circle shape*) further on.]	
	T:	Yeah, great. So the drum and trumpets come in first, then the strings and then they all get loud at the same time – is that right?	Teacher guidance in creating a more accurate representation of perception
	P4:	Yeah, and then they stop.	
	T:	Very good. So is there anything else you want to add?	
Response to teacher question = revision of work	P4:	[I'll just have one last listen… (*Listens to the music again*) Yeah, I think that's grand.]	
	T:	Ok. [Just one more question… they all go up at the end…	
Teacher guidance			

Teacher direction of task & suggestions Results in a more accurate representation	P4: And they stop. Oh, maybe I should show that.] T: Yeah, that'd be good. [Tell me, are they loud or soft when they stop? P4: They're kind of loud – they go dum dum dum (*singing*) – and then they stop. T: Ok, so could you show that they stop with a loud note? How might you do that?] P4: Em, how about this… [they stop (*adds small square shapes to the end of his map*) and they're kind of loud (*adds medium star shapes to the end of his map*)] T: That makes sense. Great! Well done.	

Codes		Themes
Teacher direction & students negotiation of task Immediate peer-questioning Verification of perception of pitch Perception of tempo Explanation of	**Group 2 (Participants 2 &4)** **T = Teacher** **<u>Map 1</u> (Piece 2)** T: [Ok, so today you have to work **together** to make a map of the music. You both made very different first maps, so I think you're both going to have very different ideas. What do you reckon is the best way to go about it? P4: Well, we'll share the mouse? P2: Yeah. T: And then, I guess, just talk about your ideas as much as you can while you're doing your map.] P4&P2: Ok, yeah (*P4 plays the music*) P4: [So will we do the start? Start off with the drums? P2: No, I think start with the trumpets… they seem to go high and low, don't they?] P4: Yeah P2: [And sort of fast]…so maybe we should put in all the circles there, and three lines coming in after	Peer dialogue about the musical features

representation to peer Peer direction in creating a more accurate representation Both perceive pitch Peer description of perception of tempo results in another listen Dialogue while listening to music Teacher questioning to verify representations already created Student response to questions = explain representations and sing Further teacher question results in re-listening to the music Discuss their representation Student direction of	it….? [So that shows up and down and fast] P4: Ok P2: [No, not there – put them all under the big one P4: Oh right] (*P4 plays the music again*) P4: [It starts off with the drums first… P2: Oh yeah P4: The drums, they start off low so maybe…] P2: [Yeah, and they stay the same pace all the time P4: Let's listen again (*P4 plays the music again*)] P4: Yeah, they stay low so…(*P4 chooses a line shape, P2 points out the smallest one*) put it down here, 'cos they're low (*P4 plays the music again and they talk as the music is playing*) P2: [Drum first… P4: Then trumpets…] P2: Maybe add the line beside the circles to show the trumpet is going fast? P4: Ok. T: [So the drums come in first then yeah? P4: Yeah, they start off low and they keep the same pace. And the trumpets start off small and get bigger P2: And the line shows they're going fast] T: [So when you say the trumpets start small and get bigger, do you mean they start quiet and get louder? P4: Eh, yeah. De-de-de-de (*singing*)] T: [And you said earlier, they were going high and low too P2? P2: Yeah, rewind to the start there P4… (*P4 plays the music again*)] P4: [It's kind of up-and-down isn't it? P2: Yeah T: Yeah I think so P4: Maybe one of these to show up-down, up-down (*dragging a zig-zag*	Collaboration results in sharing ideas for creating representations of perception Peer dialogue results in increased level of engagement with music Dialogue while listening - both participants actively involved Musical interaction Increased engagement with the music

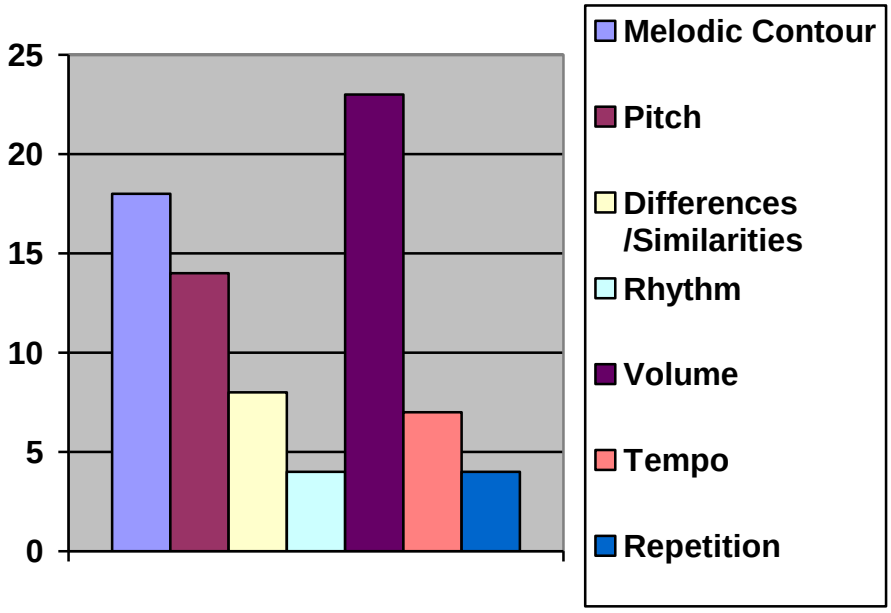
activity Sharing tasks Dialogue while listening to music Teacher guidance Peer-mentoring in creation of representation P2 understands representation Responds with his own suggestion of representation Dialogue about representation = dialogue about perception Teacher question – students respond with explanation of choice of symbol Teacher guidance in consistent use of	*shape onto the map*)] P2: Yeah.[Ok, let's listen for the strings now] P4: [Here, you take the mouse for a while P2: Thanks] (*P2 plays the music again*) P4: [The strings are in there… P2: Yeah I think so T: Can you hear them yet? P4&P2: Yeah P4: They sort of came in here (*pointing to the map*) P2: And then they came in a quick burst… there you go, that was them at the end. Kind of like two short bursts and then they stop] T: [Ok, so how are you going to show that?] P4: [For the end part, maybe we could do that… (*pointing to the curved line shape*) normal up-down, and then they go up and then they stop P2: (*Looks confused*) Here, you do it (*passing the mouse*) P4: Like this…] P2: [Aaaahhh. And maybe put a square at the end or something… P4: To show it stops, yeah] (*P4 plays the music again*) P4: About halfway through, the drums – they're small again, they start off the same time as the strings P2: [You could do – they stay the level pace all the time – so just keep these lines here and here P4: Yeah, they stop and start, stop and start] T: [Ok, and is there any reason why you've got three different size lines and not just the same one? P2: Well, they come in, and then they go a bit harder – well, in there in the middle it shows that they're not doing too much… and then they go hard at the end] T: [And do they stop suddenly like the	Positive attitude to collaboration Importance of timing of teacher intervention Peer-mentoring Possible theme: Collaboratively creating representations leads to shared understanding of musical sounds

symbols	strings at the end? P2: Yeah P4: Em, yeah T: Ok, so how would you show that? P4: Oh yeah, the square.] And in the middle, halfway through, the drum and the strings, I think they both start off at the same time T: Oh right, let's listen for that maybe (*P4 plays the music again*)	Importance of teacher intervention in creating accurate representation
Student suggests consistent use of symbols	P4: Well, halfway through, all three of them stop… so how will we do that? Will we do another square?	
Teacher question results in students re-listening to the music	P2: Make a line all the way down here… P4: [That might be too long, will we just use squares – like they all stop?] P2: Yeah T: So, do the strings really stop then, if they haven't been in the piece yet?	
Expresses perception by singing	P4: Oh yeah, let's listen again (*P4 plays the music again*)]	Student adopts idea suggested by teacher
	P4: [Oh, the strings go den-den-den-den (*singing*) P2: (*Taking the mouse*) They go from lower… up – they just keep going den-den-den-den (*singing*)]	
Teacher question to verify meaning of representation & perception of sounds	T: [Oh right, see that looks very like the trumpet shape you had at the start there P2…	
	P2: Yeah T: So does it mean the same thing?	Musical involvement of participants in activity
Student suggestion results in another hearing	P2: Well, the trumpet one starts from higher and goes to lower, but the string one goes from lower to higher] T: Ah, I see. Well done. P4: [I think the strings are in at the start too. (*P2 plays the music again*)]	
Collaborative creation of representation – dialogue about musical sounds	P4: So they start off…. (*drags a curved shape onto the map*) P2: [Where do you want it? P4: Do you want to put it diagonal? P2: There? P4: Yeah, like that. Like they start off small and then…	

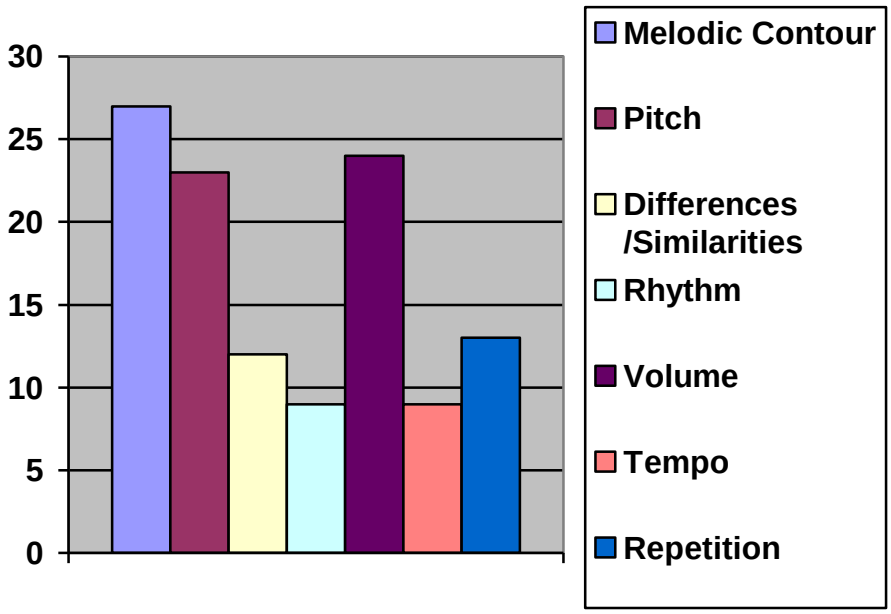
Student question leads to another listen Teacher guidance – reassures students & encourages them to create an accurate representation Peer-questioning = another hearing Student & teacher questioning = another hearing	P2: …they get bigger? P4: Yeah.] [Did you hear them stop? Do you think they stopped? P2: Em… P4: You know, halfway through… (*P4 plays the music again*)] P4: That's strings there… P2: Yeah, they stopped P4: Will we put a smaller square? P2: Oh no, hang on, they're still playing! P4: Yeah! P2: They didn't stop at all… T: [So the trumpets and the drum stop and the strings keep going… P4: Yeah, but it's dying out sort of T: Yeah it's very hard to hear isn't it? P4: So maybe if we put this (*drags a curved shape onto the map*) and then turn it around, upside down – so they start of like normal pace, then they go down really low and it's hard to hear…] T: But they're still there? P4: Yeah. And they go back up to normal. P2: And they keep the steady pace T: Very good. P4: [At the start, did you hear two of the strings? P2: I don't think so… play it again (*P4 plays the music again*) P2: Yeah] P4: Yeah, two little ones. Two circles to show… P2: …barely any (*P4 continues the music to the end*) P4: [At the end, did you hear that they all went up? T: Well, does the trumpet come back in at all?] (*P4 plays the music again*) P2: Yeah, they're still playing so far T: Yeah, but here's the bit now where you have your stop… P2: I don't think it comes back in… T: So is it just the strings going up at the end?	Peer dialogue = active, listening *for*

Peer mentoring in the creation of representation Students able to follow map & understand representation	P4: Yeah the strings, and also the drum – well they just stay on the flat line P2: [Maybe we could put a line beside the square, to show that they (*trumpets*) don't come back in P4: Where? P2: Along here… P4: (*Looks confused*) Here, you do it (*passing the mouse*) P2: There P4: Right] T: Great, well done. [So can you both follow the map ok? P4&P2: Yeah T: It makes sense to both of you? P4&P2: Yeah]	

Appendix K: Levels of perception of specific musical features



Levels of perception during individual implementation stage

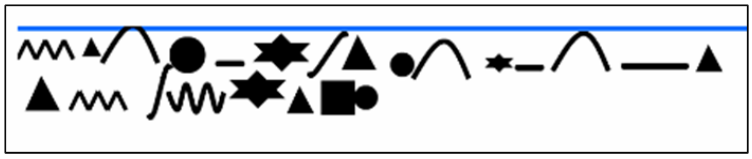


Levels of perception during individual implementation stage

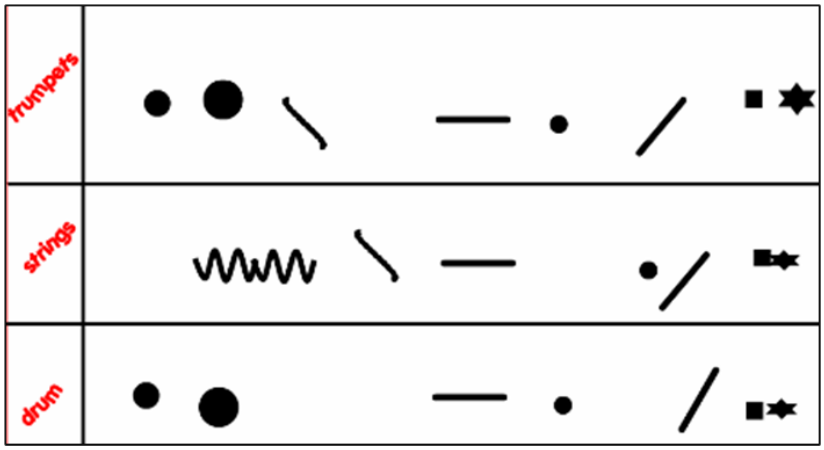
Appendix L: Categories of created maps

The complete set of created maps from both stages of implementation is available in the data folder on the CD that accompanies this paper

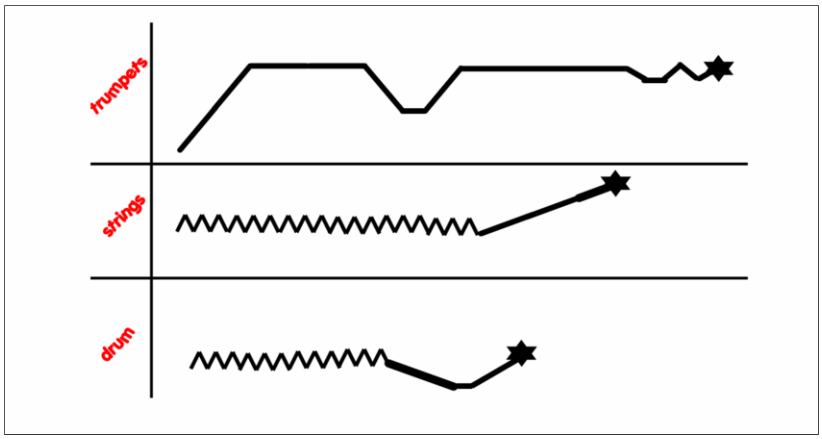
Symbolic



Participant 7: Piece 1

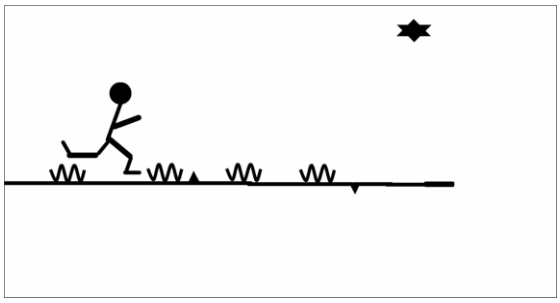


Participant 4: Piece 2

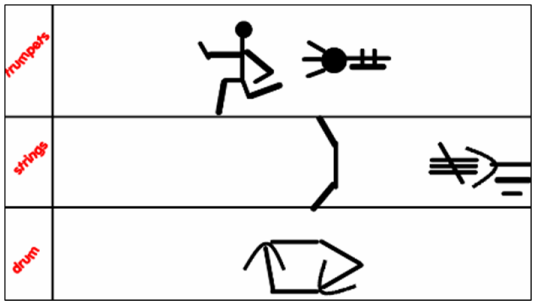


Group 1: Piece 2

Pictorial

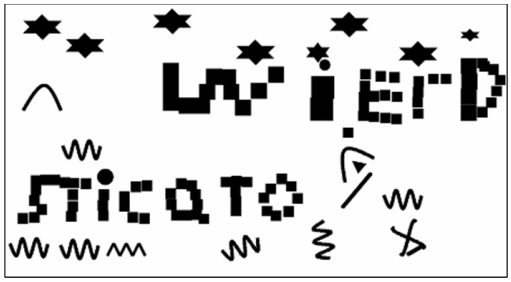


Participant 8: Piece 1: 'I thought it was sort of like someone trying to get somewhere… just like Alice in Wonderland… maybe someone running to different places.'

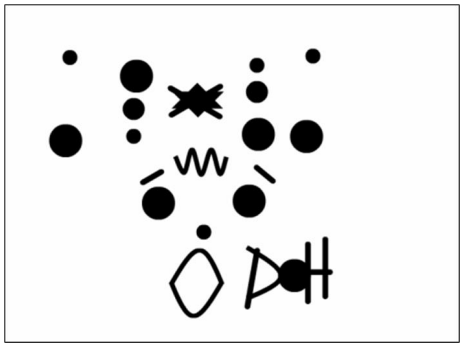


Participant 2: Piece 2: '…a soldier marching for the trumpets, 'cos it's kind of a marching tune'

Textual

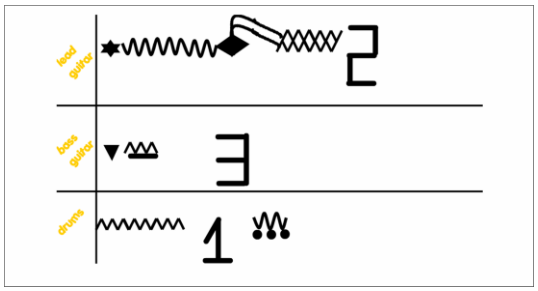


Participant 3: Piece 1: 'I wrote what I thought about the piece… I thought it was "weird" and "staccato"'.

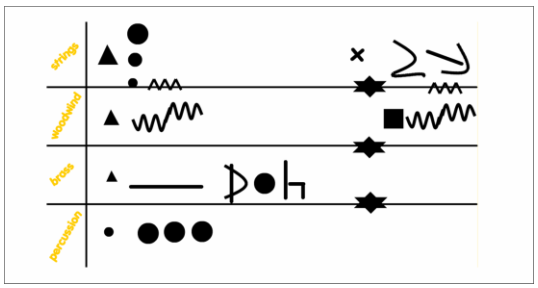


Participant 2: Piece 1: 'And then it starts getting slower… so I drew a slow person! Saying doh!'

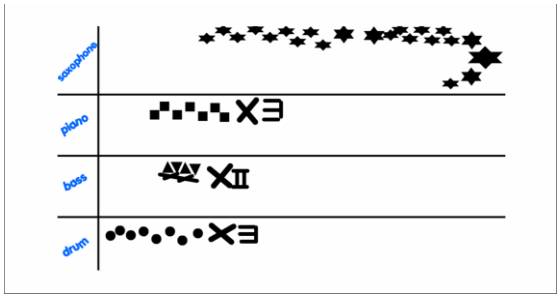
Numerical



Numbers to represent order of instrumental entries (*Group 3: Piece 5*)



Numbers to represent structure (also contains an example of textual representation) (*Group 2: Piece 6*)



Numbers to represent repetition of melodic and rhythmic idea (*Group 1: Piece 4*)