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Nick Netis
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School of Communications and Multimedia – Edith Cowan University

Bachelor of Arts -Interactive Multimedia (Honours)

Research Thesis

"What features of interactive multimedia technology maximise the motivation of primary school aged children learning music theory?"

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USE OF THESIS

The Use of Thesis statement is not included in this version of the thesis.

Abstract

This study was conducted to find out what features of interactive multimedia elements best engage children between the ages of 8 and 12 in the process of learning music theory. Previous research into similar areas has indicated that multimedia technologies, such as CD-ROM, are advantageous in teaching musical theory. A commercially available software application, Musicolour, that uses multimedia delivery of musical theory lessons, was analysed to identify the elements that the students found motivating. These features included the use of a combination of audio cues, graphical cues and interactivity. The findings were analysed to determine which multimedia elements or combination of multimedia elements were present in the software and which of those the students found most motivating. The portion of the software used was comprised of two modules. The modules that were chosen were consistent with the student's level of aural music ability. Some of the students worked through the computerised music lessons individually while others were assigned in pairs consisting of similar age and ability. The students in pairs were observed interacting with the software. On completion of the lessons the students were asked to complete a questionnaire evaluating their attitudes on the multimedia lesson to ascertain how engaging they found it. The students were also interviewed to gather their opinions about the experience of using the software. Findings from this research indicate that motivating music education software should include some features that were well accommodated as well as those that were identified as lacking or non existent in the Musicolour product. The findings reveal that a good motivational music education software package should contain features that grab and maintain the

user's attention using elements such as characters, colours, cartoons, humour and allow for creativity. The product should contain varied and challenging tasks to perform. It should contain clear, non-ambiguous instructions for tasks. It should allow the user more control over the learning environment and offer them learning aids such as on-line help, context sensitive help or the ability to easily locate and replay instructional material at one click away from where they are in the program. It should provide relevant and constructive feedback to exercises or tasks attempted. It should support collaborative learning environments. It should allow for role-playing using different types of instruments, such that the student can choose an instrument relevant to what they are learning to perform the activities within the software. The study also highlighted that the software elements of the product themselves were not the only motivating factors to the participants. Other outside factors observed were those of collaboration when working in pairs and the motivating effect of the using the computer technology.

Declaration

I certify that this thesis does not, to the best of my knowledge and belief:

i. incorporate without acknowledgement any material previously submitted for a degree or diploma in any institution of higher education

ii. contain any material previously published or written by another person except where due reference is made in the text; or

iii. contain any defamatory material

1/09/01

Nicholas Netis

1st September 2001

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Introduction

The purpose of this study was to discover the features of interactive multimedia technology that enhance the motivation of primary school aged students, between the ages of 8 and 12, learning music theory. The study analysed a commercially available music teaching multimedia software package "Musicolour" (Europress Software Ltd, 1997) to establish what motivational features were present and how effective they were. This information, plus feedback from students, was analysed to assemble a list of recommendations for the future design of engaging music theory software.

Rationale

The author of this study has 25 years experience in the music industry both as a musician and music teacher and believes that musical theory is not a mainstream subject and one that is traditionally taught in book format. He is of the opinion that many younger children find this manner of learning theory difficult, as they often require many visual prompts and interaction from the teacher. This style of teaching can also be described as somewhat boring. A key issue for the music industry is now to attract and retain student's interest in music education. Computer software has the ability to retain a child's attention and interest for long periods of time as is evident in the widespread and extended use of computer games. The reason prompting this study is that most music theory software applications on the market fall short in providing the motivational aspects required for younger children to learn musical theory. By identifying the motivational features of computer games software and analysing one of several musical theory training software packages available on the

market for its motivational aspects, it was evident which motivational elements were being utilised and which ones were lacking. This information was then used to develop recommendations for future design and development of good motivating music theory software for use in schools.

There is an increasing use of computers and the Internet to provide education to learners. According to Baltzer (1996), much of the research into teaching music theory to primary school aged children suggests that more focus is required on the capturing and maintaining of their attention span. To do this the student must be motivated to use the software. Throughout the literature, (for example Stevens, (1985), Baltzer (1996) and Raschke, (1999)), it is evident that effective teaching of musical theory should involve both sound and visual elements, and should be designed in a way that will capture and hold the attention of the learner.

Malone (1980, p3), explains the importance that motivation has in the learning process:

> *If students are intrinsically motivated to learn something, they are likely to spend more time and effort learning, feel better about what they learn and be more likely to use it in the future therefore, they will learn better. The terms "Fun", "Interesting", "Captivating" and "Intrinsically Motivating" are used interchangeably and are used to describe activities in which people engage without obvious external rewards.*

Malone's observations on motivation allow for easy identification of the descriptive characteristics that the music theory education software should include in order to motivate learners. He describes these in terms of being "Fun", "Interesting" or "Captivating".

The effects of motivational software can be seen in many of the popular computer games. Often people will spend hours playing computer games and keep going back to play them. The major reason behind this behaviour is largely due to the motivational factors included within the games. Like games, educational software should induce students to want to spend more time and effort using them and make them feel interested about what they are learning. Due to their popularity, the motivational qualities of computer games software can be examined to help identify the motivational elements that should be included in educational software.

Steinberg (1991) explains that computerised lessons can allow for motivators that are not feasible in traditional teaching environments as well as motivators that exist in traditional teaching environments. Computerised lessons can allow for students to manage their instruction rather than having it managed by a teacher and allow them to feel they are in control. The computer can create an environment that involves the students in fantasy situations and can also deliver individualised feedback about how they are progressing.

However, the benefits of educational software can be lost if it is not motivating to use, therefore it is important to identify the elements of a software package that make it motivating. This study focused on the strategies that can be employed in the design of motivational software. Through the identification of effective strategies, guidelines were developed to assist in the creation of motivating software.

Research aims

The aim of this research study was to determine what constitutes the motivational elements in a commercially available piece of interactive multimedia music theory educational software. Using this information the study then analysed which features and elements provided for the most engaging environment to hold a primary school aged student's attention in a music theory lesson. An existing piece of music theory software, "Musicolour" was used as a basis to identify the motivational elements it contained and this information was used as a baseline to inform the design of similar products in the future. The research questions below were used to address these aims.

1. **What are the motivating elements in "Musicolour"?**

2. **To what extent do these elements enhance the learning setting?**

3. **What guidelines result to inform future design of similar products?**

Elements of learning music theory

The literature contains many examples of how a combination of elements can enhance motivation or engagement of children learning aural music theory. For example, Mayer in Baltzer (1996, p33), made the comment that

> *Music is an aural art but most students are visual learners. Multimedia technology offers a way to bridge the gap. Perhaps the greatest advantage of multimedia is the ability to grab and hold the student's attention.*

Raschke (1999, p1) observes

> *The World Wide Web is transforming the study of music theory, expanding the source of learning beyond the traditional classroom. It is possible to now create a learning environment that incorporates text, narration, graphics, animation, sound and interactivity into a single multimedia experience that engages the user in cognitive thought processes that exceed capabilities of written text.*

It would be logical to conclude from the above comments that if an interactive multimedia music software package is to be motivating or engaging it must first contain aural, visual and interactive elements. However, as Waraich (1998) indicates,

the components of hypermedia systems such as sound, video and graphics are not intrinsically motivating within themselves. The multimedia elements (sound, video and graphics) provide the vehicle by which aspects of engagement can be included into educational tools.

Forrest (1995), outlines some of the advantages of using technology in music teaching as encouraging active rather than passive learning because the students actively engage in learning and producing music with the help of the computer. Stevens (1995), explains that aural reinforcement of visually perceived music and visual reinforcement of aurally perceived music is essential for the development of true musicianship, especially in the areas of ear training and music literacy.

Straker (1989) observes that computer software can assist children in composing music. It can do this by allowing a child to create and store musical phrases and arrange or rearrange musical phrases until they are pleasing to the ear. Each phrase can be represented by a pictorial symbol or metaphor. A lot of programs designed to aid music teaching have been focused on efforts to demonstrate traditional notation on a stave as the student plays. The difficulty with traditional music teaching theory is that it is unintuitive. The best music software allows a student to create, edit, manipulate and mix sounds and either hear each note or phrase as it is added or listen to the composition.

The role of motivation in learning

Motivation is described by Coopersmith (1975, p136) as 'the inner drive that is created in each one of us and that provides us with the impetus to do something.'

Cole (1994), defines intrinsic motivation as the internal drive or desire of person to do things for their own sake or self-reward. On the other hand, he explains extrinsic motivation as the need for a person to complete a task or perform an activity for the sake of a reward, privilege or externally derived satisfaction. Most students are motivated by both intrinsic and extrinsic motivation.

Some of the teaching activities that can be planned to capitalise on intrinsic motivation are outlined in Alessi & Trollip (1991). The types of activities that achieve this are those in which students will willingly participate because the content is interesting or the task is enjoyable. The following criteria defined by Alessi & Trollip (1991) can be used to ascertain whether an educational software package is intrinsically motivating:

- Encourages deeper cognitive processing
- Incorporates games
- User exploration is encouraged
- The student is given sufficient control over the environment
- The student is challenged.
- The student's curiosity is aroused
- The student is always encouraged regardless of performance.

This study was focused more on intrinsic motivation as it examined the software package to identify the elements that stimulated the internal drive of self-reward for the student.

The two major motivation theories upon which this research was based were Malone's motivational theory and Keller's theory plus the criteria outlined by Allessi and Trollip.

Malone's theory

Malone (1980) has outlined the four major characteristics of intrinsically motivating instructional environments to include the elements of: Challenge; Fantasy; Curiosity and Control:

Challenge, defined by Malone (1980), is the provision for clear criteria of performance and concrete feedback to the person, so they can evaluate how well they are meeting these criteria. Malone (1980) lists the ways that challenge can be accommodated in computer software by a variable difficulty level, inclusion of multiple level goals, inclusion of hidden information that must be actively sought out by the user, the element of randomness. Stoney & Oliver (1997), explain that the challenge criteria involve elements of problem solving, higher order thinking and an appropriate level of difficulty. For a task to be challenging the students should be aware of the goals of the program to achieve success. Stoney & Oliver (1997), also

point out that competition can be seen as a component of challenge, even competition within the person's self to improve their own performances. A challenging activity is one that lends itself to easy manipulation, yet maintains a level of complexity that stretches the student's abilities. Challenge is the process of learning by doing and manipulating objects.

Fantasy as defined by Malone, in Stoney and Oliver (1997, p 4),

> *It is the component of a learning program that makes it interesting and intrinsically motivating. Fantasy, like motivation, can be intrinsic or extrinsic. An intrinsic fantasy is one that stimulates a situation in which the skill would actually be applied. An extrinsic fantasy is one in which the learner engages in an activity in which they would not normally be able to participate, such as working fast to avoid a time bomb exploding, or getting the correct answers to avoid a person being hanged one body part at a time (hangman).*

Malone (1980), points out fantasies assist in making instructional environments more interesting and educational. "I define a fantasy-inducing environment as one that evokes 'mental images of things not present to the senses or within the actual experience of the person involved'. These mental images could be either of physical objects (darts and balloons) or of social situations (e.g. being the ruler of a kingdom)." (Malone, 1980, p. 39). According to Malone (1980), fantasy is advantageous in that by the provision of vivid imagery related to material being learned, can improve the

memory of the material. Also, in the case of simulation, the cognitive advantage is that learning a skill in an imaginary simulation aid in the ability to transfer the skill to a real world situation. (Steinberg, 1991) states that that the element of fantasy can be used in computer learning environments to allow the student to vicariously experience power, success, fame, fortune or experiences that may be unavailable to them in real life. Stoney and Oliver (1997), explain that fantasy allows for the provision of multiple settings and contexts, encourages active engagement, provides context for problem solving and feedback. This is achieved through the use of metaphors, realism and authentic contexts. They also point out that learning can only be enhanced if fantasy supports and reinforces the learning objectives of the activity. Fantasy encourages the child to transcend the immediate constraints of physical reality and become involved in the process of the activity.

Curiosity as defined by Stipek (1988, p43), 'Is when humans derive pleasure from activities and events that provide them with optimal levels of surprise, incongruity, complexity and novelty (discrepancy from expectation)'.

Malone (1980), explains that the ability to arouse curiosity through the use of intrinsically motivating environments as one of the most important features of motivation. He also states that incomplete knowledge structures induce curiosity. Malone (1980) summarises that curiosity can be included by ensuring that the learning environment should not be too complex or too simple and that it should be novel and surprising. Further work performed by Stoney and Oliver (1997), explains curiosity as

the means that the program appeals to multiple senses, random elements increase interest levels and provides a context for making decisions. This is achieved through the program attributes of chance processes, authentic setting, realistic outcomes, multiple navigation paths and use of media elements.

Therefore, the curiosity element is accommodated by use of unusual or surprising features. Curiosity invites the child's interest and exploration of the learning tool.

Control, otherwise known as autonomy, is the need to feel competent and self-determining (Stipek, 1988). The concept of control, as cited by Leper and Hodell in Raffini (1993, p71) is as follows:

> *Student's sense of control over behaviour or environment is a source of intrinsic motivation. Activity and environment that foster students' feelings of self determination and autonomy are likely to stimulate their intrinsic interest.*

Stoney and Oliver, (1997) explain that the element of control will allow a student to construct their own path through a program, control the pace at which they work and decide for themselves when coaching or help is required.
Motivation derived from control is enabled by an environment that allows for a user to determine an outcome based on their own actions or responses. Steinberg (1991), states that learner control is so motivating that it will increase the student's interest in the subject.

Keller's ARCS theory

Keller cited in Alessi (1991), suggests four factors, similar to Malone's, which are essential for motivation. These factors are comprised of the following:

- maintenance - of attention
- relevance - of the material
- confidence – of the student
- satisfaction – of the student.

This is the basis of the ARCS theory.

Keller in Small (1997), breaks the four ARCS components into sub-components as outlined below:

Attention

- *Perceptual arousal*: (Otherwise known as sensory arousal) this is created by provision of novelty, surprise, incongruity or uncertainty. An example of this in an on-line learning environment is where a student might click on a link or graphic and an unexpected response occurs. Musicolour has an example of this when clicking on a picture of three cats to simulate a "Discord" (an disharmonious sounding chord)
- *Inquiry arousal*: (Otherwise known as cognitive arousal) this is created by stimulation of curiosity by the posing of questions or problems to solve. An example of this may be a mystery novel. The book just contains printed words but the curiosity of the reader is stimulated to read on and find out what will happen next.

- *Variability*: this is created by use of a range of media or methods to teach the students – each meeting the student's varying needs.

The element of attention is best described by Small (1997) as a means for arousing and sustaining curiosity and interest. For example, the use of elements of novelty, surprise, mystery, varying text and visuals all contribute to an enjoyable environment.

Relevance

- *Goal Orientation*: This is created when the objectives or useful purpose of the instruction and criteria that needs to be met to achieve successful outcomes is presented. The objectives and Evaluation criteria should be clearly stated prior to commencement of the learning episode.
- *Motive Matching*: the objectives must meet the needs and motives of the student.
- *Familiarity*: the content should be presented in ways that are understandable and related to the learners' experiences. Examples should be presented that related to relevant real life scenarios. This may be accommodated through use of metaphors.
- An example of this in Musicolour is the metaphorical use of an octopus to represent an octave.
- *Perceived usefulness* – how the user thinks it is useful.

Confidence

- *Learning Requirements:* similar to goal orientation in that it informs the students about learning and performance requirements and assessment criteria.
- *Success Opportunities:* this provides challenging and meaningful opportunities for successful learning.

- *Personal Responsibility:* this links learning success to the student's personal effort and ability. Feedback is given on performance quality.

Satisfaction

- *Intrinsic Reinforcement:* this seeks to encourage the intrinsic enjoyment of the learning experience
- *Extrinsic Rewards:* this is given in the form of positive reinforcement and motivational feedback Token rewards can be achieved in an on-line learning environment (akin to scoring points and obtaining a rank in a computer game).
- *Equity:* this allows for maintenance of consistent standards and consequences for success, for example, the student's perception of how 'fair' the system is.

Comparison between Malone and Keller's ARCS theories

For this study a meta-theory was developed which includes motivational elements from both Malone and Keller's ARCS theories. The first stage in developing this meta-theory was to draw a comparison between the two theories. It should be noted that these theories are not exactly the same nor are they mutually exclusive. Both cover useful concepts that are relevant in the identification of motivational aspects of software for the purposes of this study. Table 1 summarises the similarities and differences between the two theories. The details of these are discussed below.

Table 1 – Summary of similarities and differences of elements contained within Malone's motivational theory and Keller's ARCS theory

Similarities and Differences	Malone's Motivational Theory	Keller's ARCS Theory
Similarities	Curiosity • Appeal to multiple senses • Use of random elements that are unusual or surprising to increase interest and provide a context for decision making	Attention • Use of range of media varying text and visuals, provision of novelty, surprise, or incongruous elements – sensory arousal • Provision for mental curiosity - cognitive arousal
	Challenge • Provision of clear criteria for performance • Involve elements of problem solving and higher order thinking with appropriate levels of difficulty	Confidence • Informs students of learning and performance requirements and criteria for assessment • Provides challenging and meaningful opportunities for successful learning • Links learning success to student's personal effort and ability
Differences	Fantasy • Allows for vicarious experience of power, success and other experiences unavailable in real-life • Provision for multiple settings and contexts • Encourages active engagement • Use of metaphors, realism and authentic contexts.	Not included in theory
	Control • Provides for autonomy – the need to feel competent and self determining • Student controls construction and pace of the learning path through the learning situation.	Not included in theory
	Not included in theory	Satisfaction • Seeks to encourage intrinsic enjoyment of learning experience • Extrinsic rewards given in form of positive reinforcement through use of token rewards. • Maintains equity, consistent standards and consequences for success – perceived 'fairness' of system
	Not included in theory	Relevance • Allows for adding value to learning experience by use of realistic objectives and purpose, clear unambiguous instructions, logical, valid and uncluttered presentation of information • Addresses issues of software usefulness to the user.

Similarities between the theories

Attention/Curiosity

The attention component of Keller's ARCS theory is akin to the element of curiosity defined by Malone.

In a multimedia software environment curiosity or attention may be stimulated through use of media types. These motivational components consist of perceptual or sensory arousal elements such as variations in light, sound, colour, animations and also cognitive or inquiry arousal factors (use of unexpected elements of surprise, novelty, incongruity, or by use of situations/scenarios posed by a question or problem resulting in a discrepancy between what is expected and what is actually experienced).

The use of novel approaches that will create curiosity or suspense can be used in computerised teaching environments as they are commonly used in games.

The cognitive factors should be used judiciously because if they are overused they may no longer be novel. Steinberg, (1991), explains that if graphics, sounds or animations are overused or used in a consistent manner the novelty may wear off and the element of surprise is lost, hence the motivational aspect is also diminished or negated.

Inquiry arousal can also be accommodated within these teaching environments by providing for context based decision inputs by the user. Elements such as chance,

unexpected events and mystery can be included with real life analogies to increase interest levels.

Confidence/Challenge

The confidence component of the ARCS theory is somewhat akin to the challenge component of Malone's theory. They are similar in the following ways.
Both theories state that clear criteria must be present to inform the students of their learning and performance requirements, and evaluation or assessment criteria must be included.

The concept of personal responsibility or competition is a similar theme in the two theories. They both outline links to learning success and the student's personal effort and ability.

They both contain the concept promoting higher order thinking and the provision of challenging and meaningful opportunities for successful learning. A computer learning activity needs to outline its goals or objectives at the outset so that the student knows what is expected of them. The activity must also allow for assessment of performance and include some means of providing feedback to the student on that performance. The feedback given allows the student to evaluate their performance and will assist them in formulating strategies on how to complete the activity successfully.

To satisfy the element of Challenge/Confidence the educational software tool must include goals and objectives, a means by which the student's performance is assessed to determine that goals and objectives are being achieved and a mechanism to provide feedback to the student on how they are progressing towards achievement of the goals and objectives.

Challenge provides opportunities to reflect and plan, encourages hypothesising and testing, and provides goals to measure performance. This is achieved through gaming elements, goal based activities, feedback, performance measures and indicators, Stoney and Oliver (1997).

Elements unique to each theory

Fantasy elements of Malone's theory

The element of fantasy allows the user to experience scenarios or situations that they may not have the opportunity of experiencing in a real life setting. This section is one which game software utilises. It allows the user to vicariously experience a situation that they would not be able to in real-life such as fame, fortune or power. Metaphors are often used to achieve this.

The computerised learning environment can provide for role-playing or scenario based learning opportunities. Sometimes the user can experience a situation in a virtual sense, for example, computer games allow users to fly aircraft, drive racing cars and play professional sporting games with their favourite teams or sporting heroes.

Educational software can also adopt the motivational element of fantasy to allow the user these virtual experiences.

Satisfaction elements of Keller's ARCS theory

The elements within this grouping are mainly concerned with how much the student was contented or satisfied with the learning tool and the outcomes from using it. It focuses on how much they enjoyed the learning experience and did they think it was useful. This element is based on user perception of usefulness and fairness of the learning tool.

The element of satisfaction can be included in computer learning environments by providing for a feeling of accomplishment on the part of the user. For example, a score of how well the student has progressed with the lesson using a self-test or a print mechanism to enable the student to print out a hard copy of what they have achieved in the lesson.

Control elements of Malone's theory

This section examines issues related to a learner being in charge of the learning situation and having the ability to construct pathways through a program to accommodate their own learning style and requirements. The learner, not the software, should be in control of the pace and navigation of the learning program.

A learning environment is more motivating to use if the user can be self-directing in how they interact with that environment. By allowing the user to control the learning environment, they are able to take charge of their own destiny and learn from their

mistakes. Control allows for students to make decisions independently and increases reflective activity. In multimedia learning environments this can be achieved through the program attributes of semi-structured, self-paced, open-ended activities with feedback to guide actions. It should also be set in a familiar context. The student feels that they are in control of the activity when they can dictate the pace and the difficulty level of the learning situation to suit their requirements.

Relevance elements of Keller's ARCS theory

In some aspects this category contains elements similar to the category of Confidence/Challenge. This category concentrates on elements related to the information and how it is presented to the user so that it will add value to a learning experience. Areas covered here include having a realistic and achievable purpose or objective with clear instructions on how to achieve them, presentation of material in a clear, unambiguous, logical, organised, valid and uncluttered manner. It also addressed issues such as how useful the user thinks the software is.

A relevant teaching environment needs to tie the instruction to the learner's experience by using materials and concepts familiar to the users that provide concrete examples and analogies related to the learners work. It should meet the learners perceived needs.

Small (1997) explains that for a computerised learning environment to have relevance it should consist of data that is credible, important, accurate and recent. It must be of

aesthetic value with interesting content that is useful, logical and diverse. The learning events must be of a reasonable difficulty level. The navigational elements must be clear, consistent, logically organised with pointers to it that can be accessed from various points.

A motivating computerised teaching environment needs to include goals that are clear and achievable, feedback on performance, elements of curiosity that remain novel and are not overused and finally, it must allow the student to remain in control of the learning environment.

It is anticipated that an educational software tool that uses a combination of all multimedia elements (sound, visuals and interactivity) and addresses the aspects of control, curiosity/attention, challenge/confidence, fantasy, satisfaction and relevance will hold the students attention for a longer timeframe, will be more challenging to the learner and that they will find the activity the most engaging.

Criteria for evaluating the motivational aspects of computerised music educational software

A combination of elements from Malone's and Keller's theories have been the basis on which the following meta-theory has been devised to evaluate interactive multimedia software for this study. Motivational elements included in traditional educational delivery can also be utilised in a computer based lesson environment.

The meta-theory consists of the following categories, devised for the evaluation of the Musicolour software:

- Stimulates interest (Curiosity/Attention) in both cognitive and sensory ways.
- Stimulates thinking (Challenge)
- Stimulates fantasy (Fantasy)
- Allowed for user control of learning situation (Control)
- Appropriate level of understanding/ perceived usefulness by the user (Relevance) – some overlapping elements exist here that are included in the challenge category
- Builds user self esteem (Confidence)
- Fulfils user satisfaction (Satisfaction)
- Technological aspects (Computer technology itself as the motivator). Described by Perez and White in Steinberg (1991).

The categories defined above are an arbitrary way of organising motivational elements from the viewpoint of conducting this study. Some of the category definitions will merge into other category definitions as identified above.

This study was conducted as a pilot study. It was designed as an exploratory exercise in an effort to analyse requirements for improving future developments of music theory educational multimedia software applications for children. Its objective was to establish what works well in a currently available multimedia package and what could be improved in future software development in this area of music education.

Critique of chosen software based on motivational meta-categories

Musicolour application

Originally several music teaching software packages for children were examined. The software application, Musicolour, used within this study was chosen for the following reasons. It was one of the best commercially available software packages that covered teaching the basics of musical theory to primary school aged children on the market at the time the study was commenced. It was deemed suitable in terms of content and user friendliness by the usual music teacher of the sample group. It was mutually agreed by the principal researcher, the research supervisor and the music teacher of the sample group that it contained the highest percentage of motivational elements in its teaching processes. The software had other technical advantages in that it could run on a PC computer platform and was not computer resource intensive in terms of memory and disk space. The software did not require sophisticated add-ins or plug-in applications to make it run. The software was mouse and keyboard controlled and operated under a standard graphical user interface. The software contained clear instructions and was user friendly. The software was also inexpensive; the retail cost was less than Aus $100.

Musicolour by Europress Software Limited is a music educational application based on a UK syllabus that includes elements such as amusing cartoon characters, encouraging games and clear vocal instructions that help children learn about the

construction of music by relating theory to visual interpretations. It includes 15 lessons and pupils start by relating notes to colours and images. Lesson 2 relates sounds and notes to colours and cartoon characters. Lesson 3 develops concepts of notes, scales and chords utilising the colours and characters introduced in Lesson 2, plus introducing new concepts to illustrate scales and chords. The software uses various interactive multimedia elements and metaphorical concepts to teach the basics of musical theory. The software builds upon concepts covered in earlier lessons to teach more complex concepts of music theory in later lessons. It is a good tool because it is aimed at primary school aged children and utilises metaphorical concepts that children between the ages of 8 – 12 can understand and relate to.

One of the aims of this study was to identify whether or not this application did include the motivational aspects that have been outlined in the literature, and if so, did they actually motivate the students interacting with the program, as the literature would suggest.

The tables below outline the motivational elements contained within the "Musicolour" software that led to the development of the questionnaire and interview instruments used in the study. These instruments were based on the meta-theory categories defined in the theoretical framework.

Table 2 - Motivational element - stimulates interest (Curiosity/Attention)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
Graphics or media elements are "eye catching" and visually pleasing. Graphics or images are animated or moving	Curiosity (Malone) Attention (Keller) – Perceptual Arousal	Use of animated graphics, sound with graphics	Cartoon characterisations of animals representing notes and sounds. Use of bright primary colours to represent notes on the scale.
Uses questions or scenarios to pose problems	Curiosity (Malone) Attention (Keller) – Inquiry Arousal	Present a "what if" scenario and allow the student to perform an action to reach a conclusion	If I play the scale and hit the down arrow what will it sound like?
Inclusion of novel, surprise or mystery elements.	Curiosity (Malone) - Variability	Use of unexpected, random occurrences of sound or animations.	An example of a discord sound using the analogy of 3 cats wailing disharmoniously.
The use of text, images and sound varies and is not repetitive.	Curiosity (Malone) Attention (Keller) - Variability	Different examples and characters are used and the same ones are not overused.	The octopus example is only used once. The cats' wailing example is only used once.
Use of Humour	Attention (Keller) – Perceptual Arousal	Incidental use of jokes or cartoon characterisations	Use of Concord and Discord characterisation examples
The software is able to capture and maintain the user interest until its logical completion or conclusion.	Curiosity (Malone) Attention (Keller) - Variability	The student is interested enough to work through the lesson until its completion.	This will be identified in the study by observing the students working through the Musicolour lessons.

Table 3 – Motivational element - stimulates thinking (Challenge)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
User has control over the difficulty level of the content.	Challenge (Malone)	Some educational software offers the user the choice of difficulty level to select.	Musicolour does not offer the student the choice of difficulty level of the lesson content.
The user is made to reflect upon decisions made or answers given while doing the lesson.	Challenge (Malone)	The software requires user to interact with the software based on a thought process. Feedback is given which alerts user to consequences of making that decision.	Lesson 3 onwards does introduce concepts that need to be carefully thought through to achieve success. An example of this is where the student is asked to pick out the correct notes from a keyboard belonging to certain chord from those displayed on a stave, if they select an incorrect note they are advised it is wrong, therefore, they need to think carefully about their next selection. If they select a correct note the note is actually played to them.

Table 4 - Motivational element - stimulates fantasy

Element on which questionnaire and interview questions are based	Theoretical base	Multimedia Example	Musicolour example
Anthropo-morphisation of characters	Fantasy (Malone)	Use of animals or inanimate objects to represent human qualities or concepts being taught.	Use of animals and fictional characters whose name starts with the same alphabetical character as the musical notes, such as genies, apes and demons to represent the musical notes A, G and D
The user is able to vicariously experience being another character or participating in a role-play situation whilst using the software.	Fantasy (Malone)	Role-play character. Flight simulator Storytelling	An example is where a composer is likened to an artist, and musical notes are likened to an artist's palette. The User has to paint a chord using an artist's palette. Another is where the student is asked to play piano keyboard via the computer screen – this allows them to vicariously experience the playing of a musical instrument. A story is presented in the form of a song that relates colours and characters to notes of a chord.

Table 5 - Motivational element - allowing for user control of learning situation (Control)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
User has ability to interact with the lesson	Control (Malone)	Input a response to a question, for example, the user inputs their name into an on-line story and the main character becomes the user's name.	Software provides ability for user to click on options or place notes on a stave and that composition is played back to them.
The user has the opportunity to go back, review or return to the home page at any time	Control (Malone)	Navigation buttons or menu options to move through the lesson in a linear pattern.	The Back, Stop and the Ear icon allows the student to repeat an instruction or to stop or rewind the lesson at any point
The user is able to use the lesson by themselves or in conjunction with other users.	Control (Malone)	Ability to collaboratively use the software. Eg a chat room facility in a networked situation.	Musicolour is a stand-alone application. The only collaboration that may occur is if two students are working together on the one workstation.
The user has a choice of navigational elements within the lesson so they can choose which part of lesson to complete	Control (Malone)	Ability to choose the next screen or previous screen or exit to another lesson from the one screen.	Software provides only for the ability to move forward or backward one screen, pause screen or repeat screen. Also able to return to main menu from each screen
Navigational cues are provided to orientate user. This provides informative feedback making the user aware of the information they have already seen and the information that has not yet been seen.	Control (Malone)		Icons are greyed out if not available to student during a lesson. Musicolour does not offer highlighted hyperlink navigation other than the Greying out of navigation icons when they are inappropriate. There is no indication of which lesson the student is in – no titles display on the screen to tell them which section they are currently in.
The sequence of lessons is logical and flows on from previous lesson appropriately	Control/Challenge (Malone)	A navigational map that indicates where the user is in the software at any given time. Text highlights in a different colour to indicate links that have been followed. Title displayed on screens to inform user which section they are currently in.	The lesson sequence in Musicolour builds on material presented in prior screens or lessons.

Table 6 - Motivational element - appropriate level of understanding/perceived usefulness (Relevance)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
Uses language and terminology appropriate to student's context	Relevance (Keller) Control (Malone) - Familiarity	Use of Language appropriate for age level and culture of students.	Uses basic English language to explain music theory concepts instead of the correct Latin terminology.
Material content is clearly related to things the student already knows about	Relevance (Keller) - Familiarity	Use of realistic day to day concepts and application of them as metaphors for the concepts in the lessons	Use of Octopus metaphor for Octave. Each tentacle representing a note of the octave.
User has access to help at all times	Relevance (Keller) – Goal Orientation	An icon is present in the same screen position in all parts of the software for the user to access if required.	Repeat icon. (Ear)
The type of information provided is appropriate.	Relevance (Keller)	Build on information learned in previous examples	A Musicolour example is in lesson 3 – Precomposition. This builds on information taught in previous lessons and on previous screens within the same lesson.
The user believes that the software is useful to them.	Relevance (Keller)	Statement of how this lessons relates to goals of student.	Statement of objectives and how these will be useful in future parts of lesson or in future lessons

Table 7 - Motivational element - builds user self -esteem (Confidence)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
The user is confident in learning the content after working through the lessons.	Confidence (Keller) – Challenge setting Control (Malone)	Use of varied and multiple challenging experiences which increase learning success	Different exercises are used to illustrate the same concepts. One example is the snake, octopus, magic circle and keyboard illustrations of notes and chords.
The user is provided with feedback on performance at the appropriate time in a positive manner.	Confidence (Keller) – Attribution moulding	Software lets you know if you have made a correct or incorrect choice of answer	Musicolour gives the user feedback when the user inputs a response to a question. It does not track an historical evaluation of the user's progress.
The user is provided with feedback on overall performance on lesson completion.	Relevance (Keller) – Attribution moulding	Software provides feedback that aligns successful outcomes to personal effort.	Musicolour only summarises what was covered in the lesson – it does not give feedback on students overall performance.
A comparison of results of current performance from previous attempts is made.			Musicolour does not accommodate this element.

Table 8 – Motivational element - fulfils user satisfaction (Satisfaction)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
The product sets an expectation of what the student will learn from a lesson and then behaves accordingly.	Satisfaction – Perceived fairness. (Keller) – Expectancy for success	Clearly explain the requirements needed to succeed and how these will be measured.	Software attempts to facilitate learning by assisting students achieving the predetermined goals and objectives. It notifies them if they have or have not met the objectives.
The software has an aesthetically pleasing interface.	Satisfaction (Keller)	Interface is pleasant to interact with. Not too cluttered, difficult to read and uses good design principles.	Primary colours used. Screens not too cluttered
Working through the lessons gives the user a satisfying feeling of accomplishment	Satisfaction (Keller) – Positive consequences	Use verbal praise, real or symbolic rewards and incentives.	Every exercise gives verbal praise for correct responses
The lessons assessed the student's performance in a fair manner	Satisfaction (Keller) – Perceived fairness	Responses to incorrectly answered questions give enough feedback to reassure the user that he/she is being treated fairly and not being tricked or deceived.	Musicolour notifies the user when an incorrect selection is made and encourages them to try again. However, it does not offer an explanation to why their selection is incorrect.

Table 9 - Motivational element - technology aspects (Use of computer itself)

Element on which questionnaire and interview questions are based.	Theoretical base	Multimedia Example	Musicolour example
The user believes that using a computer to do school work makes it more interesting.	Computer Technology (Perez and White)	Comparison of using computer to do music lessons v computerised lessons in other subject areas to ascertain whether it is the software or the technology that is the motivator.	This is not applicable to the Musicolour software. It is an outside influence not related to the motivational features within the software.

Methods

The Method for this research study required a group of primary school music students to use a portion of an aural music teaching package Musicolour" by Europress.

In the previous section a critique of the Musicolour software has been performed to identify the motivational aspects it contains.

This study consists of a comparison between the existing motivational aspects of the Musicolour application based on the theoretical framework meta-categories, as identified in the previous section and the actual findings of what the students perceived to be motivating using the techniques of observation, questionnaire and interview.

Target population

Keizel (cited in Miles and Huberman, 1994, p. 27), states that "Qualitative samples tend to be purposive rather than random." Miles and Huberman (1994), discuss qualitative research sampling, in that it uses a small sample of people within the context of the research topic and studied in-depth, such as the sample group chosen for this study. This is because there is a need to set boundaries, define aspects of the case that can be studied within a limit of time and means that connect to the research questions. The sample used in this study was homogeneous where all participants met the specific criteria of being primary school aged children between 8 -12 years old and studying music at a single school. According to Miles and Huberman (1994), a homogenous sample focuses, reduces, simplifies and facilitates group interviews. This sample was also chosen for convenience, Miles & Huberman, (1994). This was necessary due to limited timeframe, financial and manpower resources available for the study. When choosing the sample group, the following aspects outlined in Miles and Huberman (1994), were taken into consideration. The sample was relevant to the conceptual framework research questions. The sample was likely to expose the phenomena that the research was focused on, that is, the motivational elements

contained in the software. Believable descriptions and explanations, true to real-life were likely to be produced. The sample was feasible in terms of time, money, access to the participants and work style. The children in this study were students between the ages of 8 and 12 years taught by an experienced music teacher. The group were students from a primary school in Western Australia. There were 11 students in this study group – with the availability of 15 workstations. A sub-set of these students was grouped into pairs (of similar age group or instrument played). All students had a beginner level knowledge of musical theory. The study was undertaken in the latter part of term 4 of the school year, 2000 in the student's usual classroom environment.

Design

After a review of the software, the teacher had agreed that the appropriate portions of the Musicolour application were lesson 2 (which covered basics of sounds and notes) and lesson 3 (which covered basics of scales and chords) for students studying the music curriculum in this selected group. The rationale behind selection of these particular lessons was that they contained material that the students would be comfortable with. Other lessons in this software were deemed good in parts but included concepts too advanced for the level of the student's ability.

The students were asked to interact with specific features in the software. As they were completing the exercises, 2-paired groups of students were observed interacting with the software and each other. The interactions were both audio and video recorded, these were later analysed and grouped into categories of discourse. The

other methods of data collection were via a written multiple-choice questionnaire (see Appendix B) and one on one interview with the students.

Methods of data collection and analysis

Summary table

The following table was designed as a template to organise the Method (procedure) – This table was used as a means of ensuring the methods used to gather and analyse data addressed the research questions.

Table 10 - Research question 1 - What are motivating elements in Musicolour?

Data Needed	Data Collection	Analysis
Identify what elements students find motivating based on meta-theory categories. • Stimulates/Interest (Curiosity) • Stimulates Problem Solving and Higher Order Thinking (Challenge) • Stimulates Fantasy (Fantasy). • Allows for User Control (Control) • Appropriate Level of Understanding/Perceived Usefulness (Relevance) • Builds User Self Esteem (Confidence) • Fulfils User Satisfaction (Satisfaction) • Technology Aspects	*Questionnaire and Interview Questions* To elicit data from the students to identify via the interview and questionnaire which categories they found motivating.	A comparison will be done that reviews the similarities and differences between what has been identified in the Musicolour software as potential motivators and what the student's actually identify as motivating from feedback given in Questionnaire and Interview questions.

Table 11 - Research question 2 - To what extent do these elements enhance the learning setting?

Data Needed	Data Collection	Analysis
Data will be gathered about types of student interactions and time spent on each type of interaction.	Record and Transcribe the student interactions. List the dialogue and interactions that occur between students while they are using the Musicolour lessons. Observe and record in 10-minute time blocks the type of interactions occurring while doing the lessons.	Discourse Analysis (Oliver & McLoughlin, 1997) will be used to identify the numbers of types of interactions that occur during the period of time that the student is working with the software package. This should help identify to what extent the students are socialising verses learning while they are using the software over the time frame.

Table 12 - Research question 3 - What guidelines result to inform future design of similar products?

Data Needed	Data Collection	Analysis
Synthesis of all data collected for research questions 1 and 2.	Not Applicable	Motivational elements contained within the Musicolour software will be ranked in importance on how the students responded to it on the likert scale of the questionnaire. Qualitative data based on interview and observation will be synthesised to identify the salient factors of Musicolour and general issues of multimedia that the students find important. General questions will be included in interview to identify the users' preferences and expectations with regard to multimedia.

Observation

The two grouped pairs of students were observed interacting with the software. These observations were both video and audiotape recorded to aid analysis at a later point. The information gathered from these observations was:

- The approximate length of time the students spent on the Musicolour lessons – specifically identifying why the student spent that amount of time on the lesson. To capture the relevant data the students were encouraged to speak aloud about what they were thinking as they are using the software. The student interactions, body language and gestures were video recorded with a wall clock in the video frame. These observations were later transcribed.
- While working in pairs, the subjects or topics of conversation that the students discussed with one another were captured on audiotape. This dialogue was later analysed and grouped into the numbers and types of interactions that occurred.

Using Discourse Analysis (Oliver & McLoughlin, 1997), the types of interactions that occur during the period of time that the student was working with the software package were identified. The types of interactions will be grouped into Social, Procedural, Expository, Explanatory and Cognitive. These groupings assisted in identifying to what extent the students were socialising verses learning while they were using the software. For example, it was thought that if the outcome showed that the majority of interactions were of a social category then it would be logical to assume that the motivational elements of the software did not enhance the learning situation. However, if the majority of the interactions were Expository, Explanatory

or Cognitive, it would be logical to assume that motivational elements may have been a contributing factor to enhancing the learning situation. This data was used to answer research question 2.

Interviews

The researcher, Nick Netis and the student's teacher, supervised the study and had further assistance of two other research assistants in conducting the interviews. The interviews were a set of predetermined questions, which were designed to gather data on the student's attitudes and opinions about the software. This data was used to answer research questions 1 and 3. The interviews were audiotape recorded and the responses were assimilated and analysed at a later point.

Evaluation questionnaire

The students were given a written evaluation form (see Appendix B) that consisted of a horizontal likert scale rating of some specific elements of the application. The students worked through this questionnaire at their own pace after completion of the software lessons and were requested to mark the scale in the area that matched how they rated the particular element in question. The questionnaire was sectionalised into the meta-theory categories developed above and the questions were designed to elicit responses to elements contained within these categories. The intent was to gather data from the participants to see whether the software did or did not address the identified motivational features. This data was used to answer research questions 1 and 3.

Procedure conducted

The students were given a brief introduction to the software and instructions on how to open and navigate the package prior to attempting the lessons. They were directed to attempt lesson 2 and 3 only. Once they had completed the assigned tasks they were asked to raise their hand and were given the evaluation questionnaire to complete immediately so the material is still fresh in their memory.

The group of students were allocated 1 hour to attempt lesson 2 and lesson 3 of the software, however most only required 40 minutes or less. For the remainder of the lesson they were allocated time to complete the questionnaire and be interviewed about their perceptions and attitudes about the software.

The observations, interviews and the participant questionnaires provided a means for triangulation of the data.

Physical limitations of experiment

During the conduction of this study the following physical limitations were observed that were not originally anticipated:

Noise level of the software - when more than one PC was running simultaneously each PC interfered with other students (i.e. it was difficult for them to hear the sound on their own PC with all the other students using the software in the same room in close proximity to one another). This made it difficult to hear parts of the program for students, difficult to record audio student interactions when working in pairs and the noise level interfered with taping of interview responses, however most of these

interactions were captured at an acceptable level to transcribe. The software defects – the Teapot song did not work on some PC's (about 3 machines). However, the rest of the audio worked for the software. Therefore, unless the students read the words to the Teapot song, it was difficult for them to correlate cartoon character name with the note letter. Also, in some screens it was not apparent that the students needed to click on the Next screen arrow button to move on.

The other issue was that the room size and arrangement was not conducive to videotaping a large group. It can be recommended that for future experiments of this nature to ensure that headphones are made available for each student, so that noise from other workstations does not interfere with them being able to hear what is required, and does not impact any audio recording of student activity. Also ensure that a separate area located away from the main experimental area free of outside noise or interruption is available to conduct the student interviews. Despite these physical limitations the experiment was conducted successfully.

Data findings and analysis

Research question 1 - What are the motivating elements in "Musicolour"?

The answers to this question are based on findings from Questionnaire and Interview responses related to meta-theory categories of motivation that have been developed.

Table 13 summarises the questionnaire (appendix B) results grouped into meta-theory category. Figure 1 depicts this in a graphical format. The full listing of results for individual questions and questionnaire meta-theory categories can be found in Appendix B.

Table 13 – Summary of results of questionnaire by meta-theory category

Meta-theory Category	No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
Stimulates Interest (Curiosity/ Attention)	4	44	3.77	4	4	0.86	0.74	4
Stimulates Thinking (Challenge)	4	44	3.36	4	4	1.16	1.35	4
Fantasy	3	33	3.76	4	4	1.15	1.31	4
Control	3	33	3.33	4	4	1.05	1.1	4
Relevance	5	51	3.51	4	4	1.05	1.09	4
Confidence	5	53	3.91	4	4	0.81	0.66	4
Satisfaction	2	21	3.95	4	4	0.92	0.85	3
All Meta-categories	2	22	4.05	4	4	0.95	0.9	4
Technology	1	11	3.91	4	5	1.014	1.09	3
Collaboration *	1	4	4.25	4	4	0.5	0.25	1

* *Note the Collaboration question was only applicable to those students who worked in pairs; hence only 4 students answered these.*

The questionnaire contained possible values associated to the responses from 0 (if not answered) to 5 (Strongly Agree). Therefore the higher the score the more that the

respondent agreed with the statement or question being asked. Several questions were asked from each meta-theory category the columns "No of questions asked" and "Total responses" reflects this.

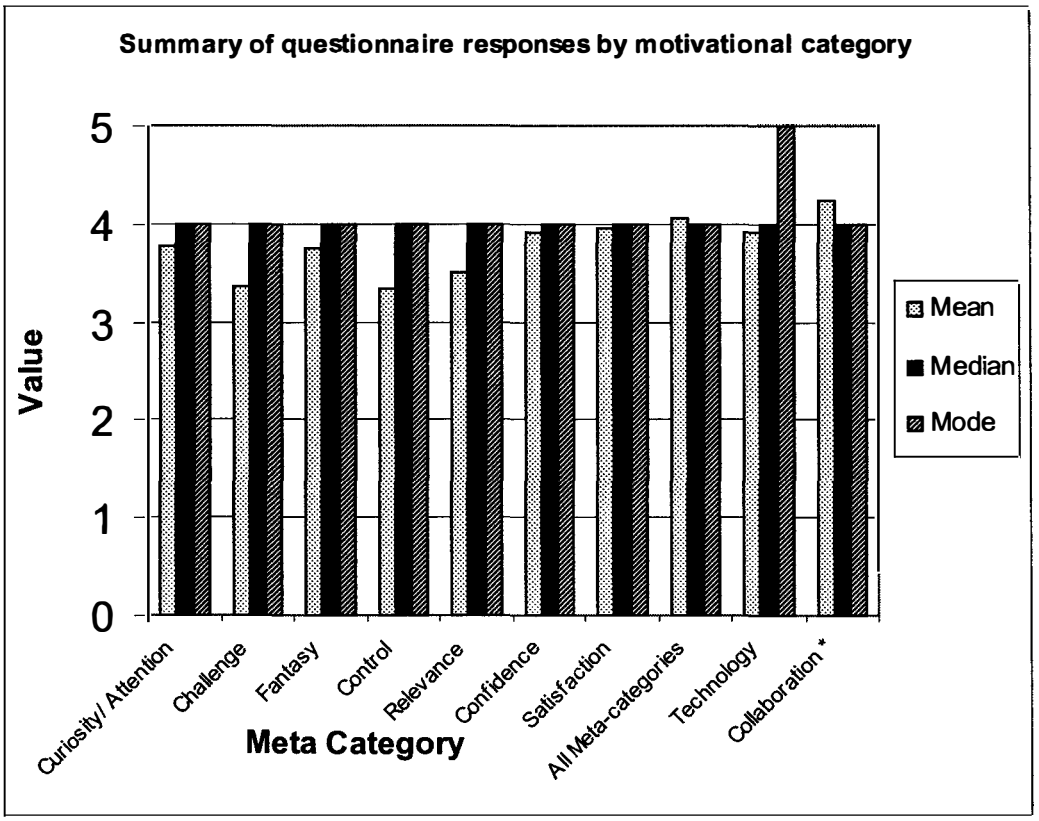

Figure 1 – Summary of questionnaire responses by motivational category

Discussion of meta-theory category "Stimulates interest (Attention/Curiosity)"

Table 14 – Summary of results of questionnaire by meta-theory category – stimulates interest (Curiosity/Attention)

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
4	44	3.77	4	4	0.86	0.74	4

The majority of responses from the questionnaire support that the respondents agreed the software contained the motivational elements of "Attention/Curiosity" as can be seen in Table 14 and Figure 1 above. The questions in this meta-theory category were broken down into the following elements, Surprise, Attention Grabbing, Capturing and Maintaining Interest. Humour appears to have played a large part in helping grab the student's attention initially and then maintains it through the initial stages of the software lessons. One student actually made the comment, "The little story was funny. The Real creatures used looked funny." The reasoning behind this is likely due to the fact that the humour element gained and maintained their interest in the lessons. When a task is funny it is also fun to do and will encourage the student to want to continue doing it.

The question relating to the "surprise" component, which was testing the users' response to the software's inclusion of novel or surprise elements that are random and unexpected, ranked highly in the questionnaire. One student responded to the interview question asking about the surprise element stating, "I wasn't expecting to see concord aeroplane or cats on the program. This surprised me" and another "They made a weird noise. They didn't make the noise they were supposed to make." These responses would indicate that the participating students found that the element of surprise in the form of incongruity or deviation from expectations was present in the Musicolour software. Photograph 1a and b below depict the Howling Cats Discord example described above.

The question relating to the "attention grabbing" component, which was testing the users response to the software's use of text, images and sound, ranked highly in the questionnaire. One student responded, "The cats howled in harmony, they made a weird noise. They didn't make the noise they were supposed to make". The incongruous use of sound and characters has provided an atmosphere of novelty, surprise and uncertainty that helps to grab the student's attention within the lesson. Once the attention is grabbed the student is compelled to want to continue working through the lesson to find out what is going to happen next.

Figure 2a - Musicolour screen print "The Wailing Cats" discord example

Figure 2b - Musicolour screen print "The Wailing Cats" discord example

The questions relating to the "maintaining interest" component ranked moderately in specific examples. Other than humour there were different mechanisms within the software helped to achieve this as individual students found different elements maintained their interest. One student stated, "Being able to hear what you had just composed. Playing it by pressing a button", indicates that their interest was maintained by use of inquiry arousal and challenge. The use of humour, novelty and surprise elements helped to maintain another student's interest as indicated by the comment, "I liked the cartoon characters – the way they were arranged in different music. The names were pretty funny (weird)."

The main components evident in the software that were identified and supported by participant responses were centred on the novelty and humour components of the cat's sound and the teapot song cartoon characters.

Figure 3 – Musicolour screen print example of the "Red Genie" cartoon character and colour representing the G note.

By utilising colourful cartoon drawings which convey meaning to the topic being taught (refer to photograph 2 above), plus random use of humour and sound files, the software has been able to grab the student's attention, maintain their interest and has stimulated their curiosity in wanting to continue working on the lesson.

Discussion of meta-theory category "Stimulates thinking (Challenge)"

Table 15 – Summary of results of questionnaire by meta-theory category – stimulates thinking (Challenge)

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
4	44	3.36	4	4	1.16	1.35	4

For the challenge category, questions were asked relating to the components of difficulty level of software, reflective thinking about decision-making and user control over difficulty level of software.

The questions relating to user control over difficulty level of the content had varied responses as reflected in the Mean scores highlighted in Table 15 and Figure 1 above. In the questionnaire, when asked if too easy, the results were inconclusive. However when asked if too difficult there was very strong support of the fact that the software was not too difficult. It is an interesting point to consider the different interpretation that the participants had on the concept of too difficult versus too easy.
Many of the students indicated that the tasks in the software were too easy, indicating that the difficulty level of the software could have been pitched a little higher for this age group. The difficulty level is actually pitched to the lower to mid range of difficulty level for the age group.

In the two particular Musicolour lessons chosen for the study one may argue that the challenge component may not have been as motivating as it could have been to all students. The problem may be that the Musicolour lessons attempted were not pitched at the correct level for the target group, or that it simply did not allow for different levels of challenge. The former seems unlikely as the music teacher of the sample group indicated that the content in Musicolour lesson 2 and 3 was at the correct theoretical knowledge level of the group. The most likely cause seems to be that the

software did not allow for various levels of challenge. The software should be able to accommodate varying levels of challenge in all of its lessons.

The questions asked that were testing if the user was made to reflect on decisions they made or answers given when using the software, ranked moderately. These results may suggest that the majority of participants did not really pay a lot of attention to their thought processes whilst working through the software. When looking at the responses from Interview questions relating to reflective thinking a lot more specific information is obtained regarding this aspect. It is evident that some students were reflectively thinking about what they were doing, for example, when asked what they were thinking about when matching colours to cartoon characters; over half of the respondents were able to describe the thought processes that took place while they were attempting this activity. For example one such response was "At first I didn't understand – but I thought it was colours but it was actually letters and characters". This type of answer clearly illustrates that the student was reflectively thinking about what they were doing during the activity. One student, while attempting to match colours to musical notes, talks about trying to match them correctly, "Match them correctly and all that. Yes sometimes try to associate colours to the animations in the story." Another student, when asked to play piano keys to match notes talked about working out the notes on the scales, "Had to work it out. With the above and below the middle line bit, I knew that the notes on the stave went from low to high, so I followed this on the keyboard". From these responses, it is evident that about half of

the participants in this sample group were able to articulate reflective thinking whilst working through the software.

It is interesting to note some of the responses to the interview question asking "What kinds of things would make the lessons more fun to do?" Some of the responses indicate that adding more variety and allowing more creativity, would have made the software more challenging. Some student responses indicated that more variety would have been beneficial. One student claimed that he found that "Maybe just being able to play piano with other instruments as well as the piano" would have been better, while another student stated, "So that I could play different/other instruments". Some students indicated that they found Challenge enjoyable and would have liked to see "Some harder games" included. An example of a response given that indicates more creativity would have been beneficial is illustrated by a student who indicated that they would like to be given the opportunity for "More of making up your own music".

The sample group in this study range in age from 8 to 12 years old. This may have had some bearing on the wide range in responses given in these questions posed about challenge components. It is possible that the students within this target group are at different developmental stages. According to his theory of development, Piaget in Slavin (1997) explains that children between the ages of 7-11 are at the concrete operational stage - capable of forming concepts, seeing relationships and solving problems but only with objects and situations that they are familiar. Children between the ages of 11 – adulthood have reached the formal operational developmental stage -

capable of abstract and symbolic thought, and that problems can be solved through use of systematic experimentation. The Age range of the target group in this study falls across the age ranges of these developmental stages and therefore, suggests that the students may be in the transitional phase between developmental stages. Children nearing adolescence can vary widely as to their level of developmental stage. Some students may be at concrete operational while some of the older students may be already formal operational stage. The different developmental stages could possibly be the reason behind the varied responses and extreme values being seen in relation to the challenge category. In order to be able to gather a more accurate picture of student attitudes to the motivational feature of challenge contained within the software, another study involving a larger stratified sample (by similar age group) should be conducted. Alternately, allowing the study group to attempt latter Musicolour lessons may yield different responses to these challenge questions, as these latter lessons appear to be more difficult and more challenging.

Discussion of meta-theory category "Stimulates fantasy (Fantasy)"

Table 16 – Summary of results of questionnaire by meta-theory category – stimulates fantasy (Fantasy)

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
3	33	3.76	4	4	1.15	1.31	4

The results indicate that the motivational element of "Fantasy" was moderately supported in Musicolour as shown in Table 16 and Figure 1 above. Within this category questions in the questionnaire were asked relating to the components of

effectiveness of anthropomorphism of characters in the software and vicariously experiencing situations in the software.

The questions testing the user's response to the effectiveness of anthropomorphism of characters as a means of representing concepts, ranked moderately well. One student observed, "the cats can sing" and another student picks up on the incongruity of it, "The singing cats were funny because you don't often hear cats sing". The anthropomorphism of the cat characters is built into the software but the users relate to it because they find the incongruity of the singing cats both surprising and humorous.

The questions which tested the student's responses to the effectiveness of vicariously experiencing piano playing or being an artist or composer as a motivational element, ranked moderately well in the questionnaire.

The following responses were given when asked if an example could be given where the software allowed them to play another character or pretend you they were in another place. One student describes role-playing as a cat, "the cats, I felt like I was with them and made a noise like them". Another student describes role-playing a composer, "when we got to write our own music, we were like a music writer". By allowing role-playing and vicariously experiencing a situation motivation is enhanced by allowing the student to transcend the immediate constraints of physical reality and become involved in the process of the activity. If the fantasy reinforces the learning

objectives as it has above example of the role-playing a composer, the learning situation will be enjoyable and more beneficial to the student.

Discussion of meta-theory category "Allows user control over learning (Control)"

Table 17 – Summary of results of questionnaire by meta-theory category – control

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
3	33	3.33	4	4	1.05	1.1	4

The results indicate a moderate level of support that software contained the motivational elements of "Control" as can be seen in Table 17 and Figure 1 above. Within this category, questions in the questionnaire were asked relating to the orientation of the user in the software, easy access to "Help" facilities within the software and navigational ease through the software. Questions relating to the presence and effectiveness of navigational cues to orientate the user in the software ranked poorly. The results tend to suggest that the respondents in this sample group believed that orientation within the software was not well handled. When asked what they liked or didn't like about the software and why, one student stated the following "When you moved on, it stays there too long and you had to keep clicking it." This response would indicate that the navigational cues were not sufficiently intuitive enough to allow the student to realise that what was required was a mouse click to progress through the lesson. There were no screen or lesson section headings to

orientate the user, nor were there any audio queues to advise them to move on to the next screen.

The questions relating to easy access to "Help" facilities within the software, which was testing the users ability to complete the lesson in the software on their own without requiring collaboration or outside assistance, was inconclusive to mildly supported in the questionnaire. This may be due to the fact that the software did not provide on-line or context sensitive help for a topic or screen. The student's often had to replay instructions or navigate back to lesson one to refresh their memory about screen icons or intended purpose of an exercise.

The questions relating to navigational ease of the user through the software, which was testing the users ability to navigate through the software in a non-linear manner ranked moderately well. The students were able to choose which lessons they attempted and could do so in a non-linear manner. However, material in latter lessons was based upon material in earlier lessons so it was logical for them to progress through these in a sequential manner. Within each lesson the student had the control to move back to a previous screen if they wished. When asked about navigation, most of the participants cited the arrow buttons as the means of moving around the software. One student stated a more specific answer to the navigational cues question, their response was "Exit, Go back to the menu, Listen again, Go back to the menu if you wanted to do it again. Use the triangle thing. I would like a special option, which would tell you what the button would do". This response demonstrates that the

navigational icons are intuitive but could be enhanced with a visual cue such as a rollover tool tip or an audio cue, which states the function or purpose of the icon.

From these responses it is easy to see that the navigational icons in the software were fairly intuitive to the majority of the respondents and that they were easily able to control which screens they accessed. This aspect of control is adequately accommodated in Musicolour.

Some aspects of control were handled adequately in the software such as the ease of navigation; however, others such as orientation and access to "Help" facilities seemed to be handled poorly according to participant responses given.

By allowing for a degree of control over the software the student feels that they are competent and self-determining in using the learning tool, therefore increasing motivation in using the software.

Discussion of meta-theory category "Relevance"

Table 18 – Summary of results of questionnaire by meta-theory category – relevance

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
5	51	3.51	4	4	1.05	1.09	4

There was a moderate level of support indicating that the software contained the motivational element of "Relevance" as indicated in Table 18 and Figure 1 above. Within this category questions were asked relating to appropriateness of language and

terminology used in the software (its appropriateness for the area of study, i.e. musical theory), the user's opinion on whether the metaphors used related to things they already knew about and the user's opinions on the perceived usefulness of the software.

The responses given in these interview questions reveal that the students were able to understand the terminology in terms of the discipline of study. When the students were asked if they could state what the section relating to the magic circle metaphor was asking them to do, most respondents indicated that they were focused on matching colours to notes or arranging notes in a chord. One student stated, "Talk about the notes and how they are associated like F, G7 – match up the notes". Interestingly, one student stated, "To make the web of chords". In this instance the student has responded to the question with another metaphor, a "web" to explain how they understood the chord arrangement concept. Most participants gave appropriate responses to this question indicating that they were able to comprehend what the program was asking of them. This is supportive of the finding that the language used within the software is appropriate for the area of study. It could be said that the terminology used was familiar to the students.

Another Interview question asked if the student could give examples in the lesson that related to real life objects animals or people, the idea behind this being that the content was presented in a way that was understandable to the user and related to their experience. The majority of students cited the valid examples used in the software

such as the cats, cartoons characters, octopus (refer to photograph 3 below), aeroplane and piano. One student explained that the cartoon characters for matching notes as, "the red genie was the 'G'." another cited, "the octopus and octave." for the octopus being used as an example for the octave. These responses cross the bounds of fantasy elements but they also indicate that the objects used in the lessons were of some relevance to them. The Musicolour software was able to present content in ways that were understandable to the users' experiences. As these examples and tasks used in lessons were relevant, then they are oriented towards the goals and motives of the student.

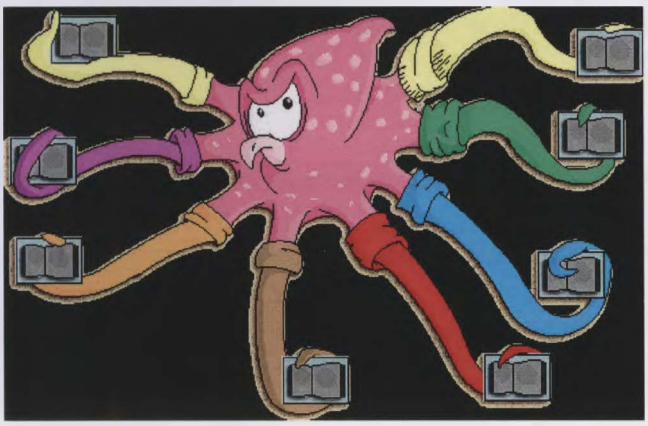

Figure 4 – Musicolour screen print example of the "Octopus" metaphor representing an octave

The opinion of the students on the perceived usefulness of the software was elicited by asking them what they most remembered about the lessons that they did. The majority of respondents indicated the composition component, for example, "the lines and comparing with piano – teaching you different notes and everything" and the characters, "the names of the creatures and the notes that go with them" as being most memorable.

When asked what they found useful in the lessons the majority of respondents indicated notes, scales and chords or composition as most useful to them. One student stated "names of creatures and helped me remember the notes" another student said the association between letters and characters as memorable, "alphabet – associated notes with animals and notes A, B, C, D, E, F, G". Interestingly all students found something useful in the lessons, the majority citing factors relating to notes, scales and composing music which was the objective of the software. This also closely relates to the responses given to the question about what they remembered most about the software, which centres on the notes, scales and composing of music.

These responses tend to indicate that the participants did perceive the software to be useful to them for their music theory class. Questions targeting the relevance of specific examples such as the magic circle and the octopus did get responses that indicated the students found them relevant insofar that they were familiar metaphors. However responses to the questionnaire question asking if the students believed that the Musicolour lessons would help them to do better in their regular music class were inconclusive. One possible explanation for this finding could be related to the fact that many students in the sample group were learning instruments other than the piano, and that as the software only used the piano instrument for scale and composing examples, they were unable to mentally connect the information learnt in the software back to their particular instrument. Software relevance is limited because it only utilises one

instrument, the piano. To be more relevant, the software should allow for more instrument options when performing tasks and exercises.

Discussion of meta-theory category "Confidence"

Table 19 – Summary of results of questionnaire by meta-theory category – confidence

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
5	53	3.91	4	4	0.81	0.66	4

Within this category questions were asked relating to the user's opinion on whether the software gave them feedback about their performance, and the user's opinions on whether the software instilled confidence in their ability to successfully complete the lessons.

The questions relating to user's opinions on whether the software gave them feedback about their performance ranked highly. One question asked the respondents about how they knew whether they had answered the questions correctly or incorrectly. The responses all indicated that the software told them. Most responses were similar to the following, "It said, 'Try again' if it was wrong and 'Excellent' if it was right". All respondents said that the program told them if they had answered correctly or incorrectly. One question asked the respondents about how they were made to feel by the program if a mistake was made when answering a question. The majority of responses indicated that they did not feel bad about making a mistake and were similar to the following, "I didn't mind, I tried again and I didn't feel bad". There was a minority of students who indicated that the software sometimes made them feel as if

they were bad or stupid, or that the software annoyed them if they kept getting the answer wrong.

Most respondents indicated that they were either confident or very confident in successfully completing the Musicolour lessons. Most also agreed that they would like to attempt other lessons in this software.

Discussion of meta-theory category "Satisfaction"

Table 20 – Summary of results of questionnaire by meta-theory category – satisfaction

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
2	21	3.95	4	4	0.92	0.85	3

The results indicate a moderate to high level of support that the software generally was satisfying as shown in Table 20 and Figure 1 above. Within this category questions were asked relating to the user's opinion on how believable the lessons in the software were and the user's opinion on the perceived fairness of the system.

The questions relating to user's opinion on how believable the lessons in the software were highly supported. One interview question asked the students if they thought the information contained in the lessons was believable. In all cases the respondents supported this question.

The questions relating to user's opinion on the perceived fairness of the system ranked as inconclusive; there was not a clear indication of support or non-support of this issue in the software.

As a method of indicating perceived fairness, the students were questioned on whether the software sets the appropriate expectation of what they will learn and if it behaves accordingly. The student's were specifically asked what they expected to happen when asked to play the piano in the program. Most students responded that they expected to be able to click on the piano keys and it would make the appropriate music. One student commented, "I expected what happened. I thought that I would just play the notes". Other comments made by the students were very similar to this. These responses indicate that the majority of participants in this sample group were satisfied that their expectations were met for this particular exercise. These findings indicate that the respondents consider the system to be fair and equitable by allowing for maintenance of consistent standards and consequences for success.

The meta-theory category of satisfaction is reasonably well accommodated by Musicolour, however there is room for improvement. The comments regarding the difficulty level should be noted for future consideration for software development, in terms of the software allowing for more intrinsic reinforcement or encouragement of the intrinsic enjoyment of the learning experience. Also the verbal feedback should not only indicate when incorrect but also offer a correct solution to a question to

prevent user frustration and allow for equity, that is, maintenance of consistent standards and consequences for success.

Discussion of meta-theory category "All meta-theory categories combined"

Table 21 – Summary of results of questionnaire by meta-theory category – all meta-categories

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
2	22	4.05	4	4	0.95	0.9	4

Table 21 and Figure 1 above show that the overall results indicate a moderate to high level of support that the respondents agreed that the software as a whole was generally motivating.

Within this category questions were asked relating to the users opinion on whether they thought the time passed by quickly while they were doing the lessons, the user's opinion on whether they believed the lessons to be fun to do.

The questions relating to users opinion on whether they thought the time passed by quickly while they were doing the lessons, the premise being that if the student is motivated by the task they will be absorbed in the task and will not notice the time passing, was ranked as moderately supported by the students. A large proportion of the respondents agreed that the time passed quickly while they were doing the lesson.

When comparing these findings to observational data from a subset of respondents (the paired groupings), this may suggest that the time passing quickly is an indication of how absorbed they were with the Musicolour task.

The questions relating to the user's opinion on whether they thought the lessons were fun to do (the assumption being that the more motivating the task the student will consider it fun to do, and that non motivating tasks would be considered boring and not fun to do), were ranked as moderately to highly supported by the students. When the students were asked about their thoughts on what would make the software more fun to do, some of the respondents indicated that the software could have been more challenging or could include more musical creativity exercises. Some students indicated that more explanation of the initial exercises would have been beneficial; one student made the statement, "I think you could explain the cartoon characters and colours. I had to read it. I didn't read it and had to go back and read it".
Some of the respondents did not have any opinion or did not think that anything could be done to make the software more fun to do.

When asked what things about Musicolour did they like best and why, there was a mixed response from the students. The main responses were related to the following elements: Cartoon characters, "The cat's meowing. I liked the colours and the cartoons. It was hard to remember the characters and colours; I really got mixed up on the demon and the genie"; Humour related to the cats howling, "humorous – the cats"; Ability to be creative with the music, "being able to listen to the different instruments and make your own tunes".

When asked about what didn't they like about Musicolour and why they did not like it, most of the students either responded by stating that there was not anything about the software that they did not like, with the majority of responses variations on the following comment made by one student, "Nothing – I liked all of it". The most common element that was determined to be what was disliked was the fact that the software was too easy. Comments were made such as, "It was a bit easy in some parts". The only other part of the software that one student commented on was the narrator's voice, "The voice was a bit annoying. The voice irritated me". The purpose of the voiceover in Musicolour was to provide information of requirements of exercises and to give verbal praise or feedback on the responses to the exercises. The voice-over in Musicolour offers verbal praise or an extrinsic (token) reward when a correct selection is made and notifies the user when an incorrect selection is made, encouraging them to try again. However, it does not offer an explanation to why their selection is incorrect. If the student keeps making a mistake the voice-over keeps repeating "No - that was not right", "No - please try again" or "No have another try". This could become quite annoying if repeated several times and may be a possible reason as to why the comment was made about the voice-over being irritating. The positive feedback, by notifying the students of correct or incorrect responses, allows them to monitor whether or not they are achieving the objectives of the lesson. The use of verbal praise is a positive consequence giving the user a feeling of accomplishment.

It would appear that elements such as Attention (characters, colours, cartoons and humour) and Creativity (creating music and playing it back) were the elements that

stood out the most in this software according to the respondents in the sample group. The software appears to be strongest in these categories as these were the elements most commonly remembered and cited by the participants as what they liked best about the software.

Discussion of other influences: "Technology"

Table 22 – Summary of results of questionnaire by meta-theory category – technology

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
1	11	3.91	4	5	1.014	1.09	3

There was a wide and even spread of responses to questions in this section. From Table 22 and Figure 1 above it can be seen that over half of the respondents agreed that technology itself was a motivating factor. While the technology itself does appear to be a motivating influence it does not appear that the novelty of using computers for schoolwork as being the cause of this. When looking at the responses given in this area, it is evident that most of the participants in this sample group use computers at school and home on a regular basis, at least 3 times a week, hence the novelty of the tool (computer technology) does not seem a likely factor. However, it may be that the fact that the computers were used in a music theory lesson was the novel element. This group normally has music lessons in a group band situation (which is a "hands-on" playing of instruments and following sheet music approach). Therefore, the use of the technology in this particular situation appears to be a novel factor for a lot of the students. As to whether this novelty element influenced the motivation of the students is not clear. When asked if they preferred doing lessons the normal way or by

computer, the responses were mixed. Some students stated that they preferred doing lessons by computer; others stated that they preferred the traditional method and some indicated that they liked both; one student's response was "Both because on the computer you can learn your basics like your notes and all that so you could have half and half. So that you could play the score that you compose in your normal lesson."

Discussion of other influences: "Collaboration"

Table 23 – Summary of results of questionnaire by meta-theory category – collaboration

No of questions asked	Total Responses	Mean	Median	Mode	Std Dev	Variance	Range
1	4	4.25	4	4	0.5	0.25	1

Only a small subset of the total participants in this study group (4 out of 11) were asked to respond to these questions, as these were the only students who worked in pairs as a collaborative exercise.

The results displayed in Table 23 and Figure 1 above indicate a high level of support for the fact that the respondents agreed that collaboration with others when working on the software was motivating. The students who worked in pairs were asked what they talked about with the other person while they were working through the software. The responses given were: "we helped each other when we weren't sure", "what to do next – if we wanted to move on to the next bit or go back. We helped each other out" and "just what to do when we couldn't work out what to do next". One student chose not to answer this question.

Interestingly the majority of the respondents who worked collaboratively found that being able to discuss the software and help each other out was beneficial.

All students in the sample group in the interview were asked if they thought it would be more fun to work through Musicolour with other people or on their own and why. Of the responses given, the students were divided on this issue. Of those who preferred to work alone the types of reasons stated were: "On your own – because you get to explore it by yourself and you don't have to share"; "Own – because you get to do it your own way. With someone else you have to agree on which way to do it" and "On my own – you get to do a lot more". This suggests that these students found having control over the software themselves as an important factor. Of those who preferred to work in groups the types of reasons stated were: "Probably better to work in pairs because you wouldn't get as many things wrong. You can help each other out"; "I think it would be more fun to work with other people because you get to ask questions and help each other out. On you own you don't get to do that"; "With other people. If you don't understand you can ask them" and "more fun to work with someone because you have someone to help you when you don't know what to do next". These responses would suggest that by being able to work on more difficult tasks collaboratively, they are able to work things out as a team.

Of the students who did work collaboratively in pairs, the majority responded that they preferred to work collaboratively in order to help each other. The other student

stated that they would prefer to work alone because they would get more done. Therefore, collaboration may be motivating to a majority of students but it is not a motivator for all students, and this is possibly due to the fact that the student feels that they surrender control when working collaboratively. Of the students who did not work collaboratively the responses were evenly divided between those who thought that working collaboratively would be more fun as opposed to working alone. Therefore, even though the sub sample group showed a majority agreed that working collaboratively had a motivating effect; the larger sample group did not necessarily hold that viewpoint. While these findings may suggest that collaboration may have a motivating effect, a larger sample of students working in pairs would be required to obtain a more accurate picture of how collaborative work affects the motivation of the students working on this software.

The motivational aspects of Musicolour

From the responses given in this study, it has been shown that all categories of motivation identified in the meta-theory are present in the Musicolour software to some degree; however some are better supported than others.

Musicolour is strong in the following categories:

- A combination of meta-theory categories
- Curiosity/Attention
- Satisfaction
- Confidence
- Fantasy

Musicolour is fair in the following categories:

- Relevance

  Musicolour ranked fair on this category. The sample group attempted only lesson 2 and 3. The lessons get progressively more challenging in the software but the later lessons were not evaluated as part of this study. The other factor may be the age range of respondents and the developmental stage they have reached.

- Challenge

  Musicolour ranked not challenging enough to a large portion of the participants. This could possibly be related to age range of respondents and the developmental stage they have reached.

Musicolour fairs poorly in the following categories:

- Control

  Musicolour ranked poorly in some aspects of control such as access to "Help" facilities and Orientation within the screens.

Research question 2 - To what extent do these elements enhance the learning setting?

This question was answered based on data gathered about types of student interactions the time spent on each type of interaction and the types of discourse that occurred between the students working in pairs.

Table 24 below summarises the discourse analysis categories, an explanation of the category, some example dialogue and some actual dialogue from this study. The full listing of results for observation data can be found in Appendix C.

Table 24 - Summary of discourse analysis categories

Type of Interaction	Explanation	Example Dialogue	Example Dialogue observed in this study
Social	Student to student talk establishing and developing a rapport	S1 – Hello Mary S2 – Hello Susie, what did you do on the weekend? S1 – I went on a picnic with....	S1 to S2 – Ok – I've had enough S2 – I wonder what's to eat today?
Procedural	Student to student talk involving information exchange on course requirements or features	S1 – What are we meant to be doing with this computer program? S2 – We are going to be learning about musical notes and scales	S1 to Research Assistant - How do you get to use the paintbrush?
Expository	Student demonstrating knowledge or skill in response to a direct request from another student.	S1 – Can you tell me how I can go back to the last screen? S2 – Yes, I think you click on this button in the bottom corner of the screen.	S1 - What do I do? S2 - From the teapot song. Yellow Canary – C and Little Green Bee - B
Explanatory	Student using another student's responses or interactions to explain knowledge and develop content	S1 – This is how we create a chord, but how do we go up or down an octave? S2 – You need to click on the up or down arrows here	S1 – And put one next to it. You can only have 4 S2 – Oh Yeah I forgot about that. S1 – I'll do the bottom 4, you do the top 4.
Cognitive	Student providing constructive feedback to another student response causing the student to reflect and consider another alternative perspective. Or student(s) constructing knowledge while working through an exercise	S1 – Why do you think that the notes played in this sequence when I did this? S2 – Probably because that is the order in which you clicked them and placed them on the stave. S1 – I found that hard to understand, did you? S2 – at first yes, but once I did it this way it was easy to do the next time.	S1 to S2 – It's different with the real piano – they are just playing right handed and when you play left handed as well you are looking at 2 lines. Doing this sounds so strange S2- I'm going to do a reverse.

The students working in pairs were tape recorded (audio and video) so that their interactions and dialogue could be captured and analysed. Using Discourse Analysis (Oliver & McLoughlin, 1997), the types of interactions that occurred during the period of time that the student's were working with the Musicolour software package were

identified. As the sound quality of the video recording was not of a good standard the audio tape recordings were used to capture this information. The types of interactions were grouped into Social, Procedural, Expository, Explanatory and Cognitive. Using discourse analysis categories helped identify to what extent the students were socialising verses learning while they were using the software. The assumption was made that if the outcome showed that the majority of interactions were of a social or procedural category then it would seem logical that the motivational elements of the software do not enhance the learning situation. However, if the majority of the interactions were Expository, Explanatory or Cognitive, it would be reasonable to assume that motivational elements may be a contributing factor to enhancing the learning situation. This assumption is based on work done by Stoney and Oliver (1999), whereby social and procedural discourse is usually lower order activity that is more mechanistic and requires almost no cognitive engagement, problem solving or decision making. Discourse that is classified as Expository, Explanatory or Cognitive can be linked to higher order thinking or a process called "Cognitive Engagement" whereby the student displays continuous, focused attention to a task requiring mental effort. The authors conclude that cognitive engagement in learning through motivation and relevance of the material to the students enhances the learning process. The following statement, taken from a study performed by (McLoughlin & Oliver, 1998, p47), examining collaborative learning in distance learning environments, describes a good pattern for discourse learning:

It was found that technology use can enhance communication and reasoning if it is used, not as a device to display syllabus content, but as a cognitive tool to enhance understanding. This was achieved by teachers in the distance classrooms increasingly engaging students in cognitive talk, rather than procedural and social discourse

Of the two groups observed in this study, the following was identified as shown in Figure 5 below. The interactions that occurred with Group 1 consisted of 52% Expository, Explanatory or Cognitive, 43% Procedural and 5%, Social. The total numbers of interactions are displayed in Figure 6 below. It is reasonable to assume that the motivational elements contained within Musicolour did enhance the learning situation for this group for majority of the lessons.

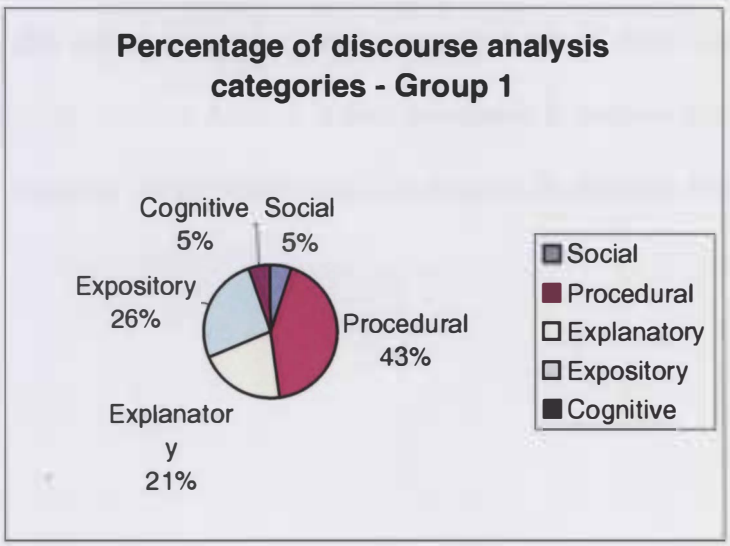

Figure 5 – Percentage of discourse analysis category observations – group 1

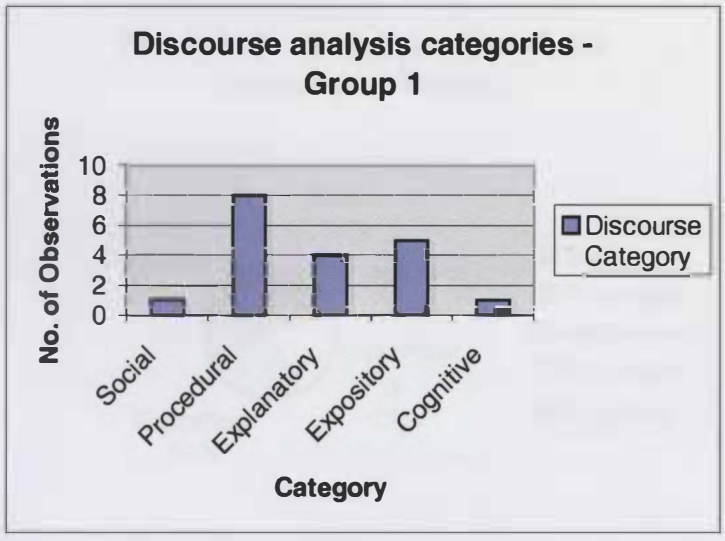

Figure 6 – Discourse analysis categories – group 1

The interactions that occurred with Group 2 consisted of 79% Expository, Explanatory or Cognitive, 6% Procedural and 15% Social, as indicated in Figure 6 below. The total numbers or interactions are displayed in Figure 7 below. Of these Social interactions, only 2 were totally unrelated to the Musicolour software. The other comments made related to opinions voiced about elements within the software by the students. Again it is then reasonable to surmise that the motivational elements contained within Musicolour did enhance the learning situation for this group.

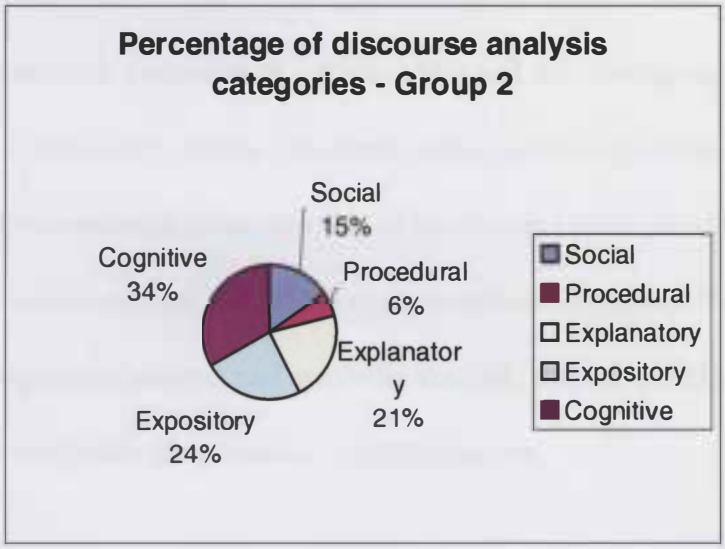

Figure 7 – Percentage of discourse category observations – group 2

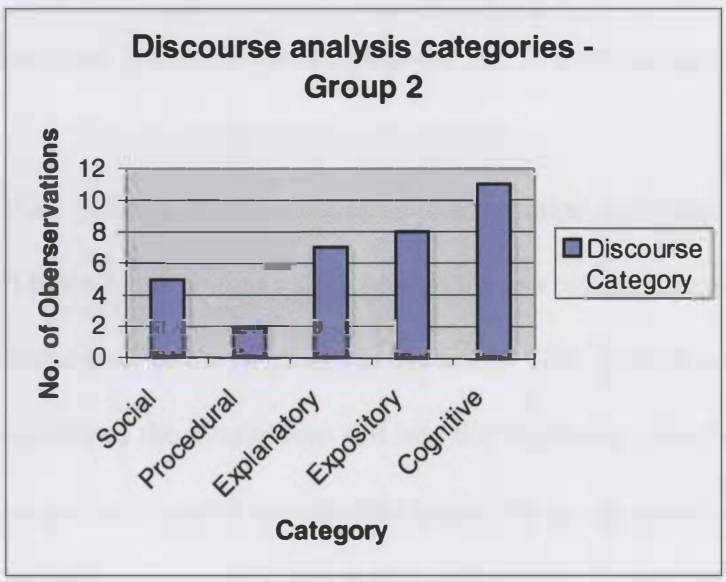

Figure 8 – Discourse analysis categories – group 2

All students from these two groups have come from the same school and the same music education class. They have the same amount of access to computers during the school day. The only observable and obvious difference being the age difference of the students in the two groups. Perhaps the difference in the percentages of

interactions across the two groups may be related to this age difference. One group were year 4 students (8 – 9 year olds) and the other group were year 6 students (10 – 11 year olds). Group 2 students, being older, may potentially have reached a higher developmental stage than that of the Group 1 students, therefore they may have been working more at the formal operational developmental level, meaning that they were capable of abstract and symbolic thought, and that problems posed could be solved through use of systematic experimentation.

The following table is a combined summary of the observed discourse analysis dialogue that was audiotape recorded of the students working in pairs. This is displayed graphically as a histogram and as a percentage chart.

When looking at the interactions of the groups combined (Figures 9 and 10 and Table 25 below), the findings showed that the interactions consisted of 69% Expository, Explanatory or Cognitive, approximately 19%, Procedural and 12%, Social. As the majority of the interactions fell into the Expository, Explanatory and Cognitive categories, it would indicate that across the group observed the majority of interactions were engaging the students.

Table 25 - Summary of observed discourse analysis dialogue

	Social	Procedural	Expository	Explanatory	Cognitive	Total
Number of Observations	6	10	13	11	12	52
Percentage	12%	19%	25%	21%	23%	100%

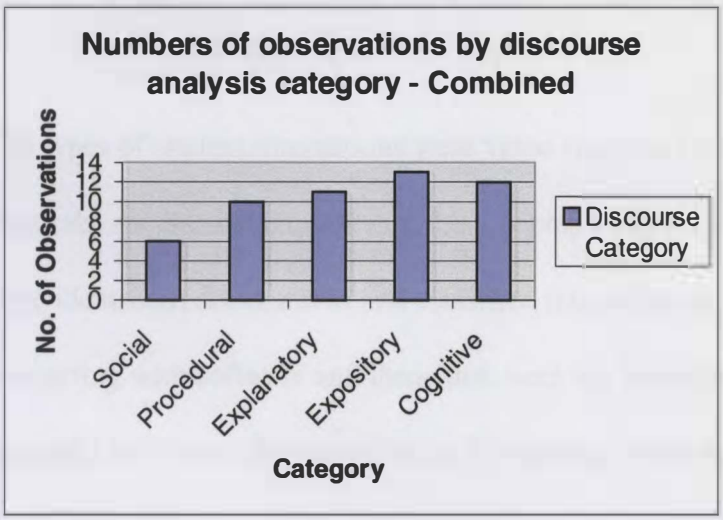

Figure 9 – Combined observations by discourse analysis category

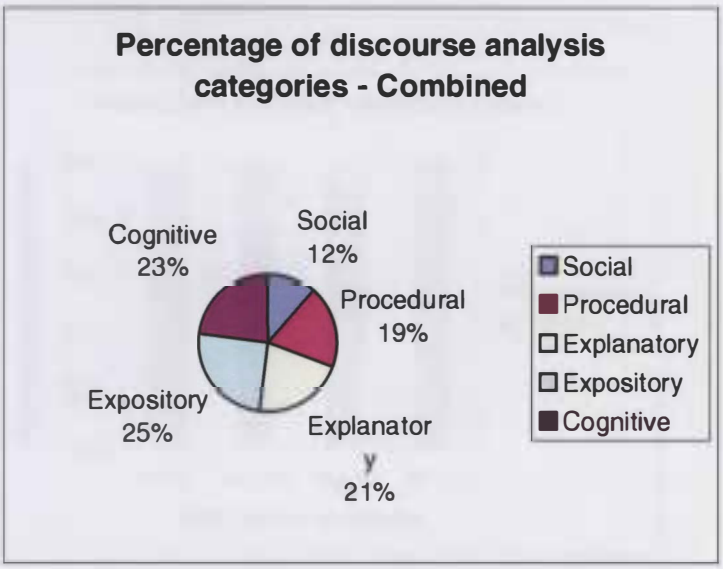

Figure 10 – Percentage of discourse analysis responses

It could be said that the students were cognitively engaged by the lesson due to the motivation and novelty of the learning environment (Stoney & Oliver, 1999). The Musicolour lessons contain motivational elements, which were the source of the students' engagement. Therefore, these motivational elements most likely did

enhance the learning situation for all of these students. This is supported by the findings in the Mcloughlin and Oliver (1998) study cited previously.

The types of student interactions were video taped and recorded in 10-minute time intervals. As the sound quality on the videotape was poor the observed interactions were identified, documented and classified into either actions involved with interacting with software and those that were not interacting with the software. For example, an interaction classified as "interacting" with the software was: Student 1 – Points to the screen and discusses with Student 2. An example of a "non-interactive" interaction was: Student 2 – looking around the room distractedly. Figure 11 below depicts these interactions.

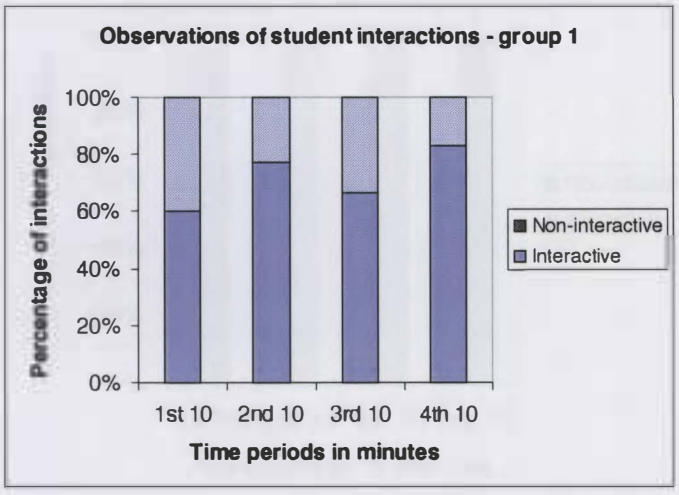

Figure 11 – Observations of student interactions – group 1

These interactions were plotted on a histogram in 10-minute time intervals to identify the level of engagement and how involved with the software the students are over the allocated time period. The purpose of this was to identify if the software maintains motivation over the duration of the allocated time or if the motivation tends to wax

and wane over that timeframe. For example, it was thought that the element of the novelty of using the technology itself may be motivating initially but the effect may wear off over time.

From the observation results recorded, Group 1 started off with a lower level of interactivity in the first time period, but that increased in the second time period, decreased marginally in the third time period and increased again in the fourth time period. There was a slow start and the interaction waned marginally after 20 minutes elapsed time. However the software was able to maintain their interest sufficiently such that it increased again to its maximum level in the last time period.

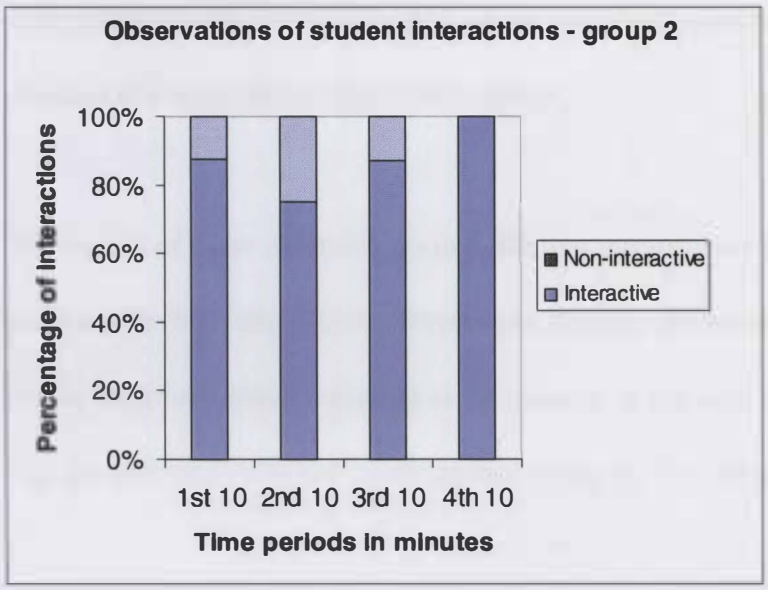

Figure 12 – Observations of student interactions – group 2

Group 2 (Figure 12) started off with a high level of interactivity in the first period. It dropped off marginally in the second time period and increased rapidly in the third time period and again in the fourth time period to a maximum of 100%. A possible explanation for the slight lapse in the second time period for group 2 is that, the initial

novelty element in the first time period kept them motivated, however by the second time period the novelty factor may have worn off and they were attempting the easy exercises in lesson 2 at around that time. These students may have found the lesson 2 activities a little too easy and not challenging enough, hence the increase in non-interactive or "distracted" behaviour such as one type of behaviour demonstrated where the student was repeatedly looking around the room distractedly and not paying attention to the computer lesson. For example, one student was observed stating "I wonder what's to eat today?" whilst looking around the room distractedly. However with the progression of time, as they moved into more difficult exercises associated with composition in lesson 3, the interactivity level was increasing again. This was demonstrated by the behaviour of looking and pointing to the computer screen and discussing it with the student team member.

The results of these observations indicate that the software was able to maintain a sufficient level of engagement throughout the time allocated to the task. Therefore, as this software remained engaging to the users over the total time period, it may indicate that the software contained motivational elements that enhanced the learning situation.

Research question 3 - What guidelines result to inform future design of similar products?

This question was answered based on findings from Questionnaire and Interview responses related to meta-theory categories of motivation that have been developed.

The importance of the motivational elements as decided by the students was based on the likert scale questionnaire ranking given to it. A comparison was made between the student responses to motivational elements and the previously identified motivational Musicolour elements. The intent was to identify which Musicolour elements ranked well with the students, versus those that did not rank well. In the process it also helped to identify other motivators that were not initially considered.

Some identified motivational elements in Musicolour did not rank well when it was thought that they may have done. This could possibly be due to poor integration into the software or that the students did not perceive them as important.

The meta-theory categories of motivation have been ranked in order of how well they were supported in Musicolour according to student responses to questionnaire items. Findings from specific questions will be included to highlight the areas that the participants stated could be improved or added to the software to make it more motivating to them.

Table 26 - Actual ranking of meta-theory categories in Musicolour according to participant feedback in questionnaire.

Rank	Category	Percentage
1	Collaboration *	85%
2	All Meta-theory Categories combined	80.9 %
3	Satisfaction	79%
4	Technology Aspects *	78.18%
5	Confidence	78.11%
6	Curiosity/Attention	75.5%
7	Fantasy	75.15%
8	Relevance	70.2%
9	Challenge	67.27%
10	Control	66.67%

* Not actual meta-theory categories identified but outside influences on motivation.

Elements that ranked well in Musicolour

It would appear that elements such as Attention (characters, colours, cartoons and humour) and Creativity (creating music and playing it back) were the elements that stood out the most in this software according to the respondents in the sample group. The software appears to be strongest in these categories as these were the elements most commonly remembered and cited by the participants as what they liked best about the software. The satisfaction and confidence categories also ranked well and these are supported by the responses given to interview questions. These types of elements should be retained in future software developments of this nature.

Elements that did not rank well in Musicolour

From the responses to interview questions asking what the students did not like about the Musicolour lessons it is evident that the categories of Challenge and Control were not well accommodated. The responses such as "It was a bit easy in some parts" and "Pretty easy – I don't know, it was too easy" indicate that the lessons attempted were not challenging enough to some of the participants. These responses lend support the poor ranking of the Challenge component. This could possibly be related to age range of respondents and the developmental stage they have reached. This finding may also be related to the fact that the students only attempted the earlier, less difficult lessons in Musicolour as part of this study.

Regarding the Control category, some responses such as "I didn't like the bit where you had to click the notes, which matched with what the animal's names were."

suggest poor orientation, which is an element of Control. Other responses tend to indicate that this part of the lesson was not well explained and many of the participants said that they had to go over this more than once to understand what was being asked of them. One student made the comment "I think you could explain the cartoon characters and colours better. I had to read it. I didn't read it at first and had to go back and read it." Interestingly, the issue of orientation and access to "Help" facilities did not rank very well in the questionnaire responses either.

Another point raised by the students as annoying, was the voice of the narrator. One student made the comment "The voice was a bit annoying. The voice irritated me" which was identified in interview and also observed on audiotape. This is an interesting point as the voices became repetitive if the student kept performing exercises incorrectly. Perhaps a different method to indicate success or failure of an exercise task may be more appropriate (for example, use of sounds or graphical indicators - a different sound for correct or incorrect answers or a different graphic or animated graphic for correct or incorrect responses would be more interesting and less irritating).

Elements that could be improved or included for future musical theory software development

1. Challenge

   One of the interview questions asked the students what their favourite types of computer software were. This was an attempt to elicit ideas on the types of

software titles that the participants find motivating generally. Most of the students indicated that games particularly adventure games or ones with role-playing or a mission were their favourite types of software. Some other responses indicated that Internet and design software was their favourite. The interactive and creative elements of the Internet and design software are the intent of these particular student responses. Clearly for future developments of this nature, the software should be able to accommodate varying levels of challenge in all of its lessons.

2. More user control

   Specifically this could be improved in future software by allowing for better orientation and "help" facilities. Some examples that have been highlighted from this study include full, clear and concise explanations of exercises and rationale behind them. The future software should also provide for better and more intuitive access to "help" facilities including context sensitive help or a program assistant type of help that is offered to the user if required. (This would be a similar concept to the paperclip used in Microsoft Word software. This program assistant help mechanism could be incorporated as one of the main characters used in the software).

3. Relevance

   This could be improved by making feedback on incorrect answers to exercises more relevant and less frustrating by offering the student the correct solution or a hint towards the correct solution. It was clear that some students did not like the

narrated voice-over telling them over and over that they were wrong or to try again.

Making more use of relevant background music and the inclusion of other instruments to do the exercises would make the software more relevant considering the aim is to teach musical theory.

Overall the sample group in this study have indicated in their responses that they consider the elements of Fantasy, Challenge and Creativity a high priority. These elements, although present to some degree in Musicolour, may be the areas for further consideration when planning and designing future software of this nature.

Recommendations for future design of music teaching software

The aim of any piece of educational software is to maximise intrinsic motivation, where motivation is inherent in the lesson and is considered fun to do. This is the type of motivation that is attained by cognitive engagement, as described by Stoney and Oliver (1999). For cognitive engagement to be present the user should be able to self-regulate their learning. The lesson should offer the student a high enough level of control and autonomy to allow them the freedom to explore the lesson without it impeding the learning objectives. The lesson should be challenging. The student's curiosity should be aroused by use of novelty elements, games and humour. The lessons should set performance expectations and encourage students regardless of their performance. The main attributes that should be included into the design of new

music educational software packages are outline below in the meta-theory categories developed for this study.

Stimulates interest (Curiosity/Attention)

These elements should be maintained throughout the lesson. The student must be kept interested and challenged throughout the lesson by means of judicious inclusion of novelty, surprise and humour elements and meaningful challenging tasks. Random or novel elements will help to maintain a student's perceptual arousal creating an inner desire to keep working through the lesson.

Sensory curiosity is aroused by the senses – this is accommodated by use of colour, animations, sound, novelty and humorous elements. This is a common theme seen in software games and other educational packages designed for primary school aged children. The inclusion of cartoon characters and music helps to assist in grabbing a child's attention. Musicolour has made use of these features to motivate the target audience.

Cognitive curiosity is aroused by information that causes a mismatch or discrepancy between the expectations of the student and what actually occurs, such as the wailing cats example used in Musicolour.

Stimulates thinking (Challenge):

If a game or piece of software is too easy or too hard it is not motivating and the student will soon become bored or frustrated with the software and lose interest in it. Therefore it is important that different levels of challenge should be accommodated in software. The student should have an option, like that given in some games software, which allows them to select the difficulty level that they would like to attempt. Alternately the examples within a lesson could get progressively more difficult and challenging as the student completes the previous exercise successfully.
The lessons should allow for reflective thinking to occur. The challenging tasks and objectives should be stated at the outset of the lesson. The challenge level should be adjustable by the student and increased automatically as the student progresses through the lesson. The students should always be encouraged regardless of performance.

Stimulates fantasy (Fantasy):

Imaginary environment for problem solving or role-plays could be accommodated. In musical theory software, role-playing using different instruments or musical performance scenarios could accommodate the vicarious experience that will allow fantasy to occur. A performance scenario may be accommodated in a role-play game where the student assumes the identity of a famous musician who is practising a piece of music for an impending concert or tour. Or the self-test could assume a game scenario such as where the student is auditioning for a place in a band or performing a music exam, which will be assessed by a panel of examiners. The accommodation of

role-play or vicarious experience not only makes the task more motivating but also puts it in a relevant context to which the student can relate.

Allows for user control over learning (Control):

The software should allow for the students to manage their own pace and direction of instruction. Allowing for user control over the learning situation is an important factor and can be accommodated via various means. Some examples of allowing control are to give the student choice of options through icons and menus. The student choice of action should dictate the consequence of what occurs in the learning task. For example, if the student selects an incorrect note in a chord, a disharmonious melody should play, exactly as the student has composed it.

According to Reeves (1997), menus and icons should allow the student to do the following: Facilitate mastery of the program; Minimise user manipulation of computer; Reduce time/energy to understand & navigate program; Enable user control of sequence; Enable user choices of where to begin; Enable user to know where they are; Help user review/return completed items; Help return to main menu;
Give feedback if wrong choice made and allow the student an option to correct choice if incorrect one is made.

The navigational aspect of control can be accommodated by means of a navigational map that indicates where the user is in the software at any given time. The text should

change colour to indicate links that have been followed and titles should be displayed on screens to inform the user of which section they are currently in.

In summary the control component should maintain the objective that all student actions within the lesson should have meaningful consequences

Appropriate level of understanding / perceived usefulness (Relevance):

The student must be able to perceive value and usefulness in solving a problem or performing a task. For example, in musical theory software it should include relevant examples and realistic exercises. It should accommodate all types of instrumentation for learning the theory aspects, not just one instrument such as piano. To be more relevant, the software should allow for more instrument options when performing tasks and exercises. The student must be able to adapt the theoretical knowledge to the particular instrument they are learning to play.

Builds self esteem (Confidence):

The expectations of the lesson must be made clear to the student. They must be given reasonable opportunity to be successful in performing a task or exercise. They should always get prompt and encouraging feedback in the event of incorrectly or correctly performing a task. Musicolour performed well in the area of giving the user feedback when the user had input a response to a question. However it did not track an historical evaluation of the user's progress. Musicolour only summarises what was covered in the lesson – it does not give feedback on students overall performance. For

music theory software to be considered strong in this area it should contain a historical evaluation of the student's progress and should offer feedback on the overall performance.

Fulfils user satisfaction (Satisfaction):

Students must be able to use what they have learnt; this can be accommodated by means of a running score on how well they have progressed. A print mechanism to enable a hard copy of the achievement should be provided.

Positive consequences should follow student progress whether or not the decision inputs made by the student are either correct or incorrect. Encouragement, not so that it is condescending, should be provided during difficult times. The student should be made to feel that the software is treating them fairly. There is a need to notify the user when an incorrect selection is made, but the software should offer an explanation as to why the selection was incorrect.

If these guidelines are followed, a very engaging and motivating multimedia music theory teaching tool could be developed relevant to the local curriculum context.

Conclusion

This study was implemented utilising a single product, Musicolour, with the purpose of identifying the strengths and weaknesses of the motivational features contained within it. The experiment was designed such that another software package could be substituted for the Musicolour product. To reproduce this study other software products would need to be reviewed using the meta-theory categories designed as part of this study. These would then be compared with the features that the target group participants identified as motivating within that product. It may not be easy to generalise the findings of this single study to the population at large due to the fact that the study is related to information gained from analysis of a single product and the interpretive nature of the analysis. In order to minimise interpretation issues, an attempt has been made to tie the questionnaire and interview questions tightly to the meta-theory categories and worded in such a way as to be unambiguous and specific in nature. Despite these limitations, some important observations regarding educational music software have been identified. The findings have indicated that motivating music education software should include some features that were well accommodated, as well as those that were identified as lacking or non existent in the Musicolour product. In summary a good motivational music education software package should contain elements that grab and maintain the user's attention using elements such as characters, colours, cartoons and humour and allow for creativity. The product should contain varied and challenging tasks to perform. It should contain clear, non-ambiguous instructions for tasks. It should allow the user more control over the learning environment and offer them learning aids such as on-line help, context

sensitive help or the ability to easily locate and replay instructional material at one click away from where they are in the program. It should provide relevant and constructive feedback to exercises or tasks attempted. It should support collaborative learning environments. It should allow for role-playing using different types of instruments, such that the student can choose an instrument relevant to what they are learning to perform the activities within the software.

Within this study it was found that other factors have provided possible sources of motivation not related directly to the software itself. The issue of working collaboratively with other students may have added to the motivational experience for some of the study group. Some pointed questions covered in the questionnaire attempted to identify whether the source of motivation was from the software or something other than the software such as the collaborative work environment. The participant's responses to these questions were mixed, and as only a small subset of the group actually worked collaboratively in pairs, the findings may not be indicative of those that could be gathered from a larger sample study group.

Another source of motivation cited by Perez and White in Steinberg (1991), from computer-based lessons that have not been covered in the theories is the computer technology itself. It is proposed that the computer technology stimulates the curiosity element of motivation and that it appears to be a type of novelty situation that does not wear off (Steinberg, 1991). The novelty of technology as a source of motivation could also have been an influence. In order to attempt to identify this as an outside

motivational source some of questions in the questionnaire were asked to identify if this was a contributing factor to the overall motivation of the product.

Collaborative working in pairs and use of the technology itself did appear to contribute to the motivational experience of this exercise for some of the participating students. Therefore, the motivational influences found from this study can not only attributed to the Musicolour software elements themselves but possibly also to these other outside factors. Further studies into the collaborative effect on motivation in primary school aged children when using educational music software could be considered as a future research topic.

It is recommended that further studies into the area of motivational elements in music education software be conducted. These studies could be approached in several ways. Firstly, the Musicolour product could be re-evaluated using the meta-category model developed in this study with a different and larger stratified grouping of students by age. This would help to consolidate or refute the findings from this small sample study. An alternate method would be to use the same sample group and evaluate other music software packages based on this meta-category model. This would be useful as a tool to compare and evaluate the motivational features of different software packages. This could also be performed with different and larger stratified sample groups to add to the validity of the findings.

The findings from this pilot study have provided some solid guidelines for any groups embarking on development of new motivational educational music software products in the future. The guidelines developed from this pilot study will be used by the author as specifications in the development of a music educational software package specifically aimed at primary school aged children learning music for an Australian syllabus. The software will be developed using a rapid application development prototype method, where a sample group of students will assist in the testing and evaluation of the motivational aspects of the software at each prototype phase. The findings from the student evaluations will assist in refinement of the product specifications and redevelopment until the most suitable motivational music education tool has been achieved for the Australian context. This software rapid application development project will be the subject of a future Masters or PhD level research study.

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Appendix A – Interview questions and student responses

Appendix A1 – Interview questions with responses

Question *<<Meta-theory category and rationale>>*	Student Response
Q1. What did you find surprising about the Concord Aeroplane and Singing Cats example? ***<< Curiosity/Attention>>*** *This attempts to elicit information about specific novel or mystery elements in Software*	1. I loved the noise – the cats. I loved it. 2. The cats sounded really bad together. The aeroplane sounded good compared to the cat 3. That you can combine the 2 together. 4. That the cats can sing 5. The screeching noise and that. I thought that the cords you were going to make where going to sound like cats. 6. I think that it was just a bit surprising. I liked it, it was funny. 7. The cats howled in harmony. 8. I thought that the music wouldn't have anything to do with the cartoons. 9. The concord – I thought of the plane that crashed. The cats – that was pretty funny. 10. They made a weird noise. They didn't make the noise they were supposed to make. 11. I wasn't expecting to see concord aeroplane or cats on the program. This surprised me.
Q2. What parts of the lesson 2 did you find funny and why? ***<< Curiosity/Attention>>*** *This attempts to elicit information about humorous elements in Software*	1. The cats. 2. The little story was funny. The Real creatures used looked funny. 3. I can't really remember lesson 2. 4. The teapot cartoons song. 5. Being able to hear what you had just composed. Playing it by pressing a button. 6. I liked the cartoon characters – the way they were arranged in different music. The names were pretty funny (weird). 7. Just doing the lesson. 8. The cartoons. The made a really nice noise. 9. The Octopus 10. The cats made me laugh. 11. The singing cats were funny because you don't often hear cats sing.
Q3. When you were asked to match the	1. Trying to get them all right.

Question *<<Meta-theory category and rationale>>*	Student Response
cartoon characters to colours in lesson 2, what did you think about? **<< Challenge>>** *This is trying to find out if specific area of Software stimulates Reflective activity on answers given or action taken by student*	2. The names of the notes in the octaves and their colours. 3. I thought it was good. 4. Complicated and annoying. I didn't hear anything. 5. I was pretty easy and pretty pointless because it didn't tell you which note was which. It just told you which colour – but you supposed to remember the actual colours. 6. Fun, a bit easy though. 7. What colours should I do. 8. At first I didn't understand – but I thought it was colours but it was actually letters and characters. 9. At the beginning I didn't know what they wanted me to do, but once I went back to it again I understood what I had to do. 10. Pretty easy, because you just needed to remember the name of the character for the colour. 11. I was trying to remember which colours the cartoon characters were.
Q4. When the lesson asked you to match colours to musical notes, what did you think about? **<< Challenge>>** *This is trying to find out if specific area of Software stimulates Reflective activity on answers given or action taken by student*	1. Match them correctly and all that. Yes sometimes try to associate colours to animations in story. 2. The creatures again – matching to colours of notes. 3. It was easier to remember the notes. 4. Nothing really. 5. On the piano? Magic circle – just remembering what you had seen before. 6. Pretty easy. 7. I don't know. 8. I don't know. 9. That was good and easy. 10. Pretty boring. 11. I thought that was good because it definitely helped you to remember the notes in the order.
Q5. In lesson 3, when you were playing the piano keys to match the notes what did it make you think about? **<< Challenge>>** *This is trying to find out if specific area of Software stimulates Reflective activity on answers given or action taken by student*	1. Had to work it out. With the above and below the middle line bit I knew that the notes on the stave went from low to high so I followed this on the keyboard. 2. The higher the notes on the scale were the higher on the keyboard. 3. Piano. 4. Nothing.

Question *<<Meta-theory category and rationale>>*	Student Response
	5. The different scales – one end of the keyboard was high. 6. The music notes you are pressing. 7. Whether I should do it high or low. 8. About my piano lessons I used to do. 9. Easy. Playing the piano. 10. I don't know. 11. The piano was a bit hard to use because you had to get the pointer in exactly the right spot on the piano and that was sometimes a bit difficult.
Q6. What is your opinion on the difficulty level of the Musicolour lessons that you did? ***<< Challenge>>*** *This is trying to find out if specific area of Software stimulates Reflective activity on answers given or action taken by student*	1. Just right. 1. It wasn't that difficult. 2. Not difficult. 3. Four out of Ten – Easy. 4. It is about 8, 9 and 10 year olds level (years 4, 5 and 6 – pretty easy). I am a year 6 student. 5. Easy – not too easy, just easy. 6. Medium. 7. It wasn't that hard 8. Just right. 9. Pretty easy. 10. Not that hard really.
Q7. Can you give an example where the program allowed you to play another character or pretend you were in another place? ***<< Fantasy>>*** *This is trying to elicit if Software allowed for motivational elements of role play or story telling through vicarious experience of character or situation*	1. The cats, I felt like I was with them and made a noise like them. 2. No. 3. No. 4. No – not really. 5. Oh, when you folded the piece of paper to make lower and higher sounds. 6. No – not really. 7. When we got to write our own music. We were like a music writer. 8. No. 9. The octopus. 10. No. 11. No.
Q8. What types of choices were you given to move to another screen when working through the material in lesson 3? ***<< Control>>*** *Identifies whether user was able to interact with Software and control his/her path through it, using a choice of navigational elements and navigational cues*	1. Exit, Go back to the menu, Listen again, Go back to the menu if you wanted to do it again. Use the triangle thing. I would like a special option which would tell you what the button would do. 2. The arrow buttons down the bottom. They were easy to understand. 3. Arrow keys. 4. (No answer given)

Question *<<Meta-theory category and rationale>>*	Student Response
	5. The different chords. 6. Don't really know. 7. No – I can't remember. 8. The long notes and quick notes. 9. Lots of choices. If you didn't want to do it you clicked the next and clicked back if you wanted to go back. 10. The buttons. 11. Arrow buttons.
Q10. In lesson 3, for the section selecting notes in the magic circle, what do you think that the program was asking you to do? ***<< Relevance>>*** *Testing to see if Software presents concepts in appropriate language and terminology for the student's context*	1. Talk about the notes and how they are associated like F, G7 – match up the notes. 2. Match the colours and the notes. 3. Teach you about the way the notes are arranged. 4. Don't know. 5. It was asking you to learn the colours so that when you saw the notes you said "Oh that was a 'C'". For people that didn't know the single note placement. 6. Make the magic circle (All in circle). Remember the notes and order and chords. 7. To select the notes. 8. Playing the scale in the scale order. 9. To make the web of chords. 10. Select the notes in the chord. 11. Can't remember.
Q11. Was the information you learned in the lesson believable? ***<< Relevance>>*** *Tests to see if the user believes the information in the software was useful to them*	1. Yes 2. Yes 3. Yes 4. Yes 5. Yes 6. Yes 7. Yes 8. Yes 9. Yes 10. Yes 11. Yes
Q12. Can you tell me about some examples that were given in the lesson that related to real life objects animals or people? ***<< Relevance>>*** *Trying to elicit whether metaphors or examples used in software to convey concepts related to things the student already knows about*	1. Relates to both. The octopus. 2. The red genie was the "G" and the cats. 3. I can't really give an example 4. Not really. 5. The octopus and the octave, the animals and the characters. 6. No, except for the cats.

Question *<<Meta-theory category and rationale>>*	Student Response
	7. Can't remember. 8. Cartoons and piano. 9. The characters – nothing else. 10. The cats. 11. The chords using the aeroplane and the cats.
Q13. What do remember most about the lessons that you did? ***<< Relevance>>*** *Attempts to find out more about perceived usefulness of information in the Software to the student*	1. The lines and comparing with piano – teaching you different notes and everything. 2. The names of the creatures and the notes that go with them. 3. The cats. 4. Not sure. 5. Probably comparing your notes and matching your chords. 6. The magic circle. The cats and concord. The piano notes letting you do your own song. 7. The colouring in bit. 8. Composing. 9. Easy to do and fun because you made up your own music and you played it and heard it if it sounded weird. 10. It was fun because it had jokes mixed in with your work and it wasn't just boring. 11. The order of the notes on the scale.
Q14. What did you find useful in the lessons that you did? ***<< Relevance>>*** *Attempts to find out more about perceived usefulness of information in the Software to the student*	1. Everything. I loved everything – can I go back on it again? 2. Names of creatures and helped me remember the notes. 3. The notes. 4. Notes and scales 5. Probably the chords. 6. Teaching me how to compose my own music. 7. The notes and that. 8. Concord and cats 9. Alphabet – associated notes with animals and notes A,B,C,D,E,F,G. 10. I learnt something while I was playing with the program. I think I learnt about the chord web. 11. The song – being able to read the keyboard music.
Q15. In lesson 3, when asked to play the piano, what did you expect to happen? ***<< Satisfaction>>***	1. I clicked on the piano – ding, ding music. 2. Press keys on piano and be able to play them.

Question *<<Meta-theory category and rationale>>*	Student Response
Attempts to find out whether Software sets the appropriate expectation of what the student will learn and behaves accordingly	3. Expected the computer to be waiting for me to play. 4. Make a song. 5. Just the note that you hit according to the colours that were in the magic circle. 6. I don't know – just to play the right notes or be told if it wasn't right. 7. For it to make the noise, to make the note sound. 8. I expected what happened. I thought that I would just play the notes. 9. It should go to the next - then it went to the next note. 10. I thought you were going to use the keyboard for the notes like A,G,F. 11. That you had to click on the right key to play the beat.
Q16. How did you know if you answered the questions correctly or incorrectly? ***<< Confidence>>*** *Tests to see if Software delivers feedback on performance of specific tasks in appropriate and timely manner*	1. I don't know – I just tried because it told me "Yes you're right". 2. The computer would tell you "Excellent" for yes. 3. If I didn't answer it correctly it would say "No please try again". 4. They told you. 5. It said "Try Again" if it was wrong and "Excellent" if it was right. 6. Man on program voice said if it was correct. 7. The computer would tell me if it was right or wrong. 8. It would tell you. 9. It told you. 10. When you answered them incorrectly it would tell you and when you answered it correctly it would tell you. 11. It told you if you were.
Q17. How did the program make you feel if you made a mistake when answering a question? ***<< Confidence>>*** *Tests to see if Software delivers feedback on performance of overall tasks in appropriate and timely manner*	1. I didn't feel bad or dumb. I just went back on it again – I liked making mistakes. 2. It didn't make me feel bad. 3. I should try again. 4. It made you feel stupid. 5. Sometimes it could be annoying if you keep getting it wrong – it keeps coming back. Otherwise it was alright. 6. It didn't really matter. 7. Nothing. 8. To try again. 9. I don't know.

Question *<<Meta-theory category and rationale>>*	Student Response
	10. Not bad – just good. 11. I didn't mind, I tried again and I didn't feel bad.
Q18. What didn't you like about the lesson? Why didn't you like it? ***<< Satisfaction >>*** *Attempts to elicit information and ideas about negative or non motivating aspects of software from student's perspective*	1. Nothing – I liked all of it. 2. It was a bit easy in some parts. 3. Nothing – I liked it all. 4. Pretty easy – I don't know, it was too easy. 5. Probably nothing – I liked most of it. 6. Easy. I did like the computer and I liked the games. 7. Nothing – I liked it all. 8. The voice was a bit annoying. The voice irritated me. 9. I didn't like the bit where you had to click the notes which matched with what the animals' names were. 10. When you moved on, it stays there too long and you had to keep clicking it. 11. I liked the colour chords drawing attention to the screen when you were playing it.
Q19. What kinds of things would make the lessons more fun to do? ***<< Satisfaction >>*** *Attempts to elicit information and ideas from student's about other motivating aspects or elements that could be considered for inclusion into this type of software*	1. Grade 2 stuff – easier stuff. Cartoons were OK they made me laugh. I liked it the way it is. 2. Maybe just being able to play piano with other instruments as well as the piano. 3. Background music. 4. Some harder games. 5. More talking. Not just piano playing. 6. I think you could explain the cartoon characters and colours. I had to read it. I didn't read it and had to go back and read it. 7. So that I could play different/other instruments. 8. Not sure. 9. More of making up your own music. 10. I don't really know. 11. Nothing.
Q20. What do you like better, doing lessons the normal way or doing lessons by the computer? ***<< Technology aspects >>*** *Testing to see if Technology itself is a motivating factor for the student in this exercise*	1. I don't mind either way. 2. By computer. 3. Doing lessons by computer. 4. Both. 5. Both because on the computer you can learn your basics like your notes and all that so you could have half and half. So that you could play the score

Question *<<Meta-theory category and rationale>>*	Student Response
	that you compose in your normal lesson. 6. By computer. 7. The computer 8. Computer. 9. Normal way. 10. Computer. 11. Computer.
Q21. If you worked with another person, what did you talk about to the other person? << This question is only for those students who worked in pairs >> ***<< Collaboration aspects >>*** *Attempting to elicit information on whether the student actually found it is more motivating to work on this software alone or in a team. Highlights the impact of the collaboration effect as a motivational or a distracting factor*	1. No (worked individually) 2. No (worked individually) 3. No (worked individually) 4. No (worked individually) 5. No (worked individually) 6. No (worked individually) 7. No (worked individually) 8. Yes (no response given) 9. Yes (helped each other when you weren't sure). 10. Yes (what to do next - if we wanted to move onto the next bit or go back. We helped each other out) 11. Yes (Just what to do when we couldn't work out what to do next).
Q22. Is it more fun to work through Musicolour with other people or on your own and why? ***<< Collaboration aspects >>*** *Attempting to elicit information on whether the student believes it would be / or was more motivating to work on this software alone or in a team and the reasons why. Highlights the impact of the collaboration effect as a motivational or non motivational factor*	1. I don't mind either way. I don't mind working by myself or with someone else. 2. On your own – because you get to explore it by yourself and you don't have to share. 3. I am not sure as I didn't work with anyone. I worked on my own. 4. On my own. 5. Probably better to work in pairs because you wouldn't get as many things wrong. You can help each other out. 6. I think it would be more fun to work with other people because you get to work with other people. Because you get to ask question and help each other out. On you own you don't get to do that. 7. Own – because you get to do it your own way. With someone else you have to agree on which way to do it. 8. With other people. If you don't understand you can ask them. 9. On my own – you get to do a lot more. 10. With another person. Probably because you got help if you didn't

Question *<<Meta-theory category and rationale>>*	Student Response
	know something. 11. More fun to work with someone because you have someone to help you when you don't know what to do next.
Q23. What are your favourite types of computer software programs? ***<< ALL meta-categories>>*** *This attempts to elicit ideas on the types of software titles that students find motivating generally. If these programs contain other elements not within Musicolour they can be used in a follow up research study to examine other motivational aspects not considered here.*	1. Games – all games and software for little kids. I just like them. 2. Games. 3. I don't really have a favourite. 4. Adventure games 5. Games (adventure) and the Internet. 6. Internet and Design 7. Games 8. Games with a mission. Role-playing games. 9. Creating web pages 10. Adventure games 11. Games and programs that teach you stuff.
Q24. What things about Musicolour did you like best and why? ***<< ALL meta-categories>>*** *This attempts to elicit ideas of what specific elements within Musicolour the student found motivating. It may shed light on other elements or factors not initially considered in this study.*	1. The cats' meowing. I liked the colours and the cartoons. It was hard to remember the characters and colours; I really got mixed up on the demon and the genie. 2. Being able to listen to the different instruments and make your own tunes. 3. Very colourful and lets you hear different notes. 4. Humorous – the cats 5. Being able to make your own decisions. Not just going through the program, you can make it go back and forward, not just going from block to block. 6. Cartoon characters – they were cool. 7. The plane, the colouring in and playing the song. 8. Cartoons because they were hilarious. 9. Cartoon and cats because they were funny. 10. I liked the piano because it was the best part of the program. 11. I liked being able to play on the computer and the way it gave you examples that were animals.
Q25. How often do you use computers?	1. Whenever I can get onto them (1 –3 times a week). I don't have one at

Question *<<Meta-theory category and rationale>>*	Student Response
<< ALL metacategories>> *This will help to identify whether the technology itself is a novelty or a source of anxiety for the student. (I.e. if the student does not user computers regularly it could be either one of the above, whereas if the student is a regular computer user the Technology effect on motivation may be negated.*	home. 2. Every day. 3. Every day. 4. Three times a month. 5. Once/Twice a week. 6. Every day. 7. Most days. 8. Six times a week. 9. Nearly every day. 10. Once or twice a day. 11. All the time.

Appendix B – Questionnaire response summaries

Appendix B1 – Individual questionnaire questions with responses

(Please refer to next page for layout of questionnaire tool given to participants with the responses and analysis embedded below each question)

Musicolour Questionnaire with summary of student responses.

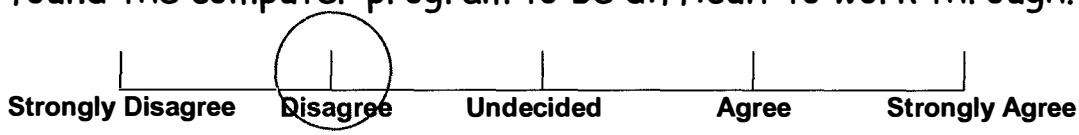
This is an anonymous questionnaire. Please ensure that you do not write your name, or other comments that will make you identifiable, on the attached.

Instructions

Read each question carefully. For each question on this questionnaire make a circle around your answer just like the example below. When you have finished answering these questions, raise your hand so the questionnaire can be collected.

Example Question

I found the computer program to be difficult to work through.



LEGEND

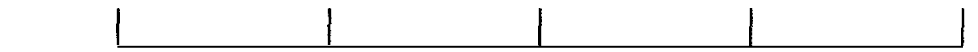
<< Meta-theory Category being tested Rationale or element that question addresses in the meta-theory category>>

Descriptive statistics will be used to interpret the data from the Questionnaire. This is an attempt to analyse the significance of each of the meta-theory categories within the software. These descriptive statistics will be supported with qualitative statements that were made by the students during their interviews as a means of triangulation of the data.
In order to compute measures of central tendency (Mean, Median and Mode) and measures of Dispersion (Range, Standard Deviation), the individual responses for each question will be given a numeric value. 1 – 5. This is indicated in red brackets in the response summary.

Depending on how the questions have been asked the numeric value allocated will be as follows:
Strongly Disagree=1; Disagree=2; Undecided=3; Agree=4; Strongly Agree=5. or alternately Strongly Disagree =5; Disagree =4; Undecided =3; Agree =2; Strongly Agree =1. If a question has no response given it will not be allocated a score.

The reason for the difference in the numbering for different questions is so that when adding the values across questions belonging to the same meta-theory category an accurate picture of the Mean, Median and Mode will be portrayed which indicates the student's attitudes.

1. **The concord aeroplane and singing cats examples of the lesson surprised me.**



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

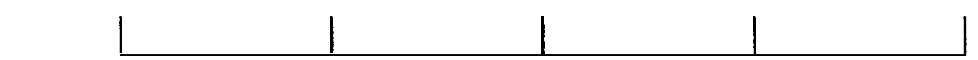
- **There were 11 responses to this question**

Strongly Disagree	(1)	1	x 1	=	1
Disagree	(2)	1	x 2	=	2
Undecided	(3)	2	x 3	=	6
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	0	x 5	=	0
TOTAL			11		37

<<Curiosity/Attention **Testing the user response to the software's inclusion of novel or surprise elements that are random or unexpected>>**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.36	4	4	1.03	1.05	3

2. **I found the screens in lesson's 2 and 3 grabbed my attention**



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

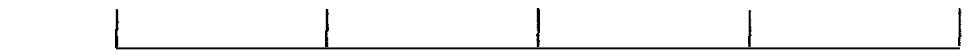
- **There were 11 responses to this question**

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	4	x 3	=	12
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	0	x 5	=	0
TOTAL			11		40

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.64	4	4	0.5	0.25	1

<<Curiosity/Attention **Testing user response to software use of text, images, sound (varies and is not repetitive)>>**

3. I found the story part of lesson 2 made me want to explore the lesson further



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

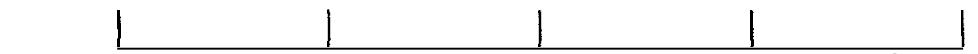
- **There were 11 responses to this question**

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	2	x 2	=	4
Undecided	(3)	1	x 3	=	3
Agree	(4)	6	x 4	=	24
Strongly Agree	(5)	2	x 5	=	10
TOTAL			11		41

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.73	4	4	1.01	1.02	3

<<Curiosity/Attention **Testing specific area of software for its ability to capture and maintain user interest>>**

4. The lesson made me feel that I wanted to keep working through it to find out what would happen next.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- **There were 11 responses to this question**

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	0	x 3	=	0
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	4	x 5	=	20
TOTAL			11		48

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.36	4	4	0.5	0.25	1

<<Curiosity/Attention **Testing software generally for its ability to capture and maintain interest>>**

5. The computer lessons were too easy.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
5	4	3	2	1

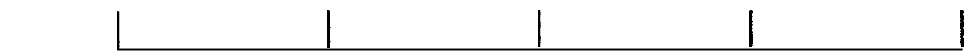
- There were 11 responses to this question

Strongly Disagree	(5)	1	x 5	=	5
Disagree	(4)	3	x 4	=	12
Undecided	(3)	3	x 3	=	9
Agree	(2)	1	x 2	=	2
Strongly Agree	(1)	3	x 1	=	3
TOTAL			11		31

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	2.82	3	1, 3 & 4	1.4	1.96	4

<<Challenge Testing user control over difficulty level of content>>

6. The lesson made me think about what I needed to do next.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

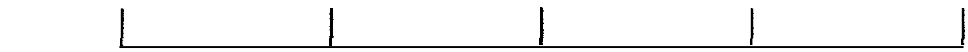
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	2	x 2	=	4
Undecided	(3)	3	x 3	=	9
Agree	(4)	6	x 4	=	24
Strongly Agree	(5)	0	x 5	=	0
TOTAL			11		37

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.36	4	4	0.81	0.65	2

<<Challenge Testing if user is made to reflect on the decisions they have made or answers given when using the software>>

7. The computer lessons were too difficult.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
5	4	3	2	1

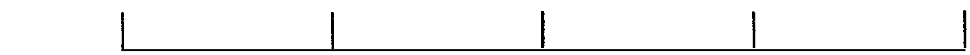
- There were 11 responses to this question

Strongly Disagree	(5)	4	x 5	=	20
Disagree	(4)	6	x 4	=	24
Undecided	(3)	1	x 3	=	3
Agree	(2)	0	x 2	=	0
Strongly Agree	(1)	0	x 1	=	0
TOTAL			11		47

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.27	4	4	0.65	0.42	2

<<Challenge Testing user response to their control over difficulty level of content of software>>

8. I found that computer lessons did not suit my age group



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
5	4	3	2	1

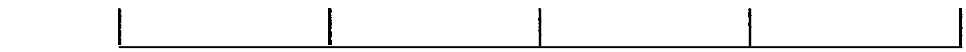
- There were 11 responses to this question

Strongly Disagree	(5)	1	x 5	=	5
Disagree	(4)	3	x 4	=	12
Undecided	(3)	3	x 3	=	9
Agree	(2)	3	x 2	=	6
Strongly Agree	(1)	1	x 1	=	1
TOTAL			11		33

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3	3	2,3, & 4	1.18	1.40	4

<<Challenge Testing user response to their control over difficulty level of content of software>>

9. I found the cartoon characters in lesson 2 to be entertaining.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

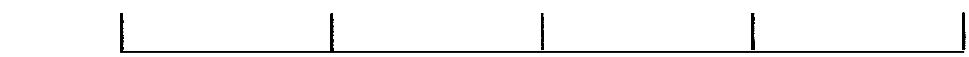
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	1	x 2	=	2
Undecided	(3)	0	x 3	=	0
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	3	x 5	=	15
TOTAL			11		45

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.09	4	4	0.83	0.69	3

<<Fantasy Testing effectiveness of anthropomorphism of characters as a means of representing concepts as a motivational element>>

10. I found the part of the lesson where I got to create musical patterns fun to do.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

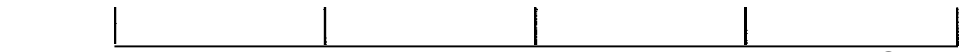
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	1	x 3	=	3
Agree	(4)	4	x 4	=	16
Strongly Agree	(5)	6	x 5	=	30
TOTAL			11		49

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.45	5	5	0.69	0.47	1

<<Fantasy Testing reaction to specific elements in software - vicariously experiencing piano playing (piano playing role-play) as a motivational element>>

11. I found that the lessons allowed me to pretend that I was a different person or character or in another place.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

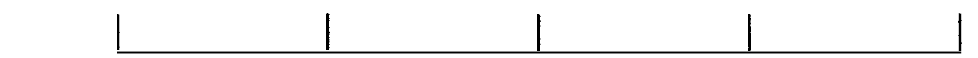
- There were 11 responses to this question

Strongly Disagree	(1)	2	x 1	=	2
Disagree	(2)	2	x 2	=	4
Undecided	(3)	4	x 3	=	12
Agree	(4)	3	x 4	=	12
Strongly Agree	(5)	0	x 5	=	0
TOTAL			11		30

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	2.73	3	3	1.10	1.22	3

<<Fantasy **Testing reaction to specific elements in software - vicariously experiencing being like an artist painting musical notes as a motivational element>>**

12. I knew exactly which part of the program I was in, from any screen.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

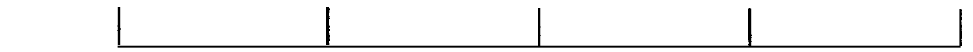
- There were 11 responses to this question

Strongly Disagree	(1)	1	x 1	=	1
Disagree	(2)	5	x 2	=	10
Undecided	(3)	4	x 3	=	12
Agree	(4)	1	x 4	=	4
Strongly Agree	(5)	0	x 5	=	0
TOTAL			11		27

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	2.45	2	2	0.82	0.67	3

<<Control **Testing for presence and effectiveness of navigational cues to orientate the user in the software>>**

13. The lesson allowed me to get help when I needed it.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

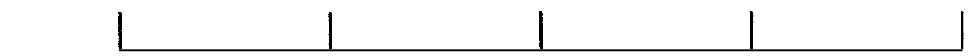
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	2	x 2	=	4
Undecided	(3)	2	x 3	=	6
Agree	(4)	6	x 4	=	24
Strongly Agree	(5)	1	x 5	=	5
TOTAL			11		39

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.55	4	4	0.93	0.87	3

<<Control A test for ability of user to complete lesson in software by themself without requiring collaboration or outside assistance>>

14. I was able to move to a different part of the lesson or another lesson whenever I wanted to.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

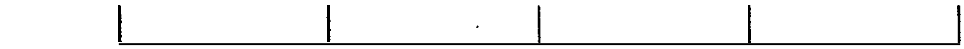
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	1	x 2	=	2
Undecided	(3)	0	x 3	=	0
Agree	(4)	8	x 4	=	32
Strongly Agree	(5)	2	x 5	=	10
TOTAL			11		44

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4	4	4	.77	.60	3

<<Control A test for the ability of the user to navigate through the software in a non-linear manner>>

15. The lesson explained exactly what I was meant to do in words that I could easily understand.



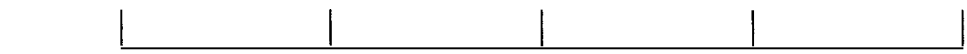
- **There were 11 responses to this question**

Strongly Disagree	**(1)**	**0**	**x 1**	**=**	**0**
Disagree	**(2)**	**1**	**x 2**	**=**	**2**
Undecided	**(3)**	**4**	**x 3**	**=**	**12**
Agree	**(4)**	**4**	**x 4**	**=**	**16**
Strongly Agree	**(5)**	**2**	**x 5**	**=**	**10**
TOTAL			**11**		**40**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.64	4	3, 4	0.92	0.85	3

<<Relevance **A test to see if the software uses language and terminology appropriate to the student's context>>**

16. I found that all situations presented in the lesson were related to things that I already know about.



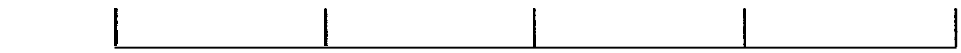
- **There were 10 responses to this question**

Strongly Disagree	**(1)**	**1**	**x 1**	**=**	**1**
Disagree	**(2)**	**2**	**x 2**	**=**	**4**
Undecided	**(3)**	**4**	**x 3**	**=**	**12**
Agree	**(4)**	**2**	**x 4**	**=**	**8**
Strongly Agree	**(5)**	**1**	**x 5**	**=**	**5**
TOTAL			**10**		**30**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	3	3	3	1.15	1.33	4

<<Relevance **A test to see if the software generally uses concepts or metaphors or content related to things that the student is familiar with >>**

17. I thought that the 8 tentacles of the Octopus helped me to understand the concept of 8 notes in an Octave.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

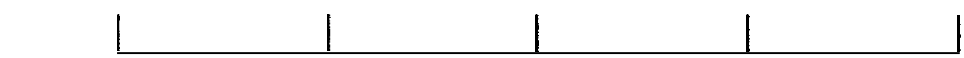
- **There were 10 responses to this question**

Strongly Disagree	**(1)**	**1**	**x 1**	**=**	**1**
Disagree	**(2)**	**1**	**x 2**	**=**	**2**
Undecided	**(3)**	**1**	**x 3**	**=**	**3**
Agree	**(4)**	**6**	**x 4**	**=**	**24**
Strongly Agree	**(5)**	**1**	**x 5**	**=**	**5**
TOTAL			**10**		**35**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	3.5	4	4	1.18	1.39	4

<<Relevance **A test of a specific element in the software to see if it uses concepts or metaphors or content related to things that the student is familiar with >>**

18. I thought that the Magic circle made it difficult for me to understand the concept of scales.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
5	4	3	2	1

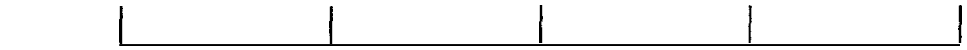
- **There were 10 responses to this question**

Strongly Disagree	**(5)**	**3**	**x 5**	**=**	**15**
Disagree	**(4)**	**5**	**x 4**	**=**	**20**
Undecided	**(3)**	**0**	**x 3**	**=**	**0**
Agree	**(2)**	**2**	**x 2**	**=**	**4**
Strongly Agree	**(1)**	**0**	**x 1**	**=**	**0**
TOTAL			**10**		**39**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	3.9	4	4	1.10	1.21	3

<<Relevance **A test to see if a specific element in the software uses language and terminology appropriate to the student's context>>**

19. I think that I would be able to do better in my regular music class now by having done these Musicolour lessons.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

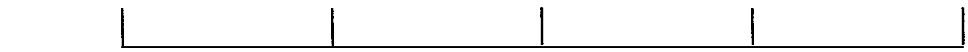
- **There were 10 responses to this question**

Strongly Disagree	**(1)**	**0**	**x 1**	**=**	**0**
Disagree	**(2)**	**1**	**x 2**	**=**	**2**
Undecided	**(3)**	**4**	**x 3**	**=**	**12**
Agree	**(4)**	**4**	**x 4**	**=**	**16**
Strongly Agree	**(5)**	**1**	**x 5**	**=**	**5**
TOTAL			**10**		**35**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	3.5	3.5	3,4	0.85	0.72	3

<<Relevance **A test to identify student's perceived usefulness of the software>>**

20. I was happy with the way I performed the Musicolour lessons.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- **There were 10 responses to this question**

Strongly Disagree	**(1)**	**0**	**x 1**	**=**	**0**
Disagree	**(2)**	**0**	**x 2**	**=**	**0**
Undecided	**(3)**	**0**	**x 3**	**=**	**0**
Agree	**(4)**	**8**	**x 4**	**=**	**32**
Strongly Agree	**(5)**	**2**	**x 5**	**=**	**10**
TOTAL			**10**		**42**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	4.2	4	4	0.42	0.18	1

<<Confidence **A test to see if the student thinks that the software gave them feedback on their overall performance on lesson completion>>**

21. While I was doing the lesson I felt that I was going to do it successfully.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

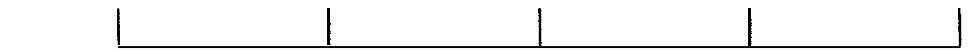
- There were 10 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	1	x 3	=	3
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	2	x 5	=	10
TOTAL			10		41

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	4.1	4	4	0.57	0.32	2

<<Confidence **A test to see if the software instils confidence in the student in the ability to learn the lesson concepts>>**

22. When I was doing the lessons I was told if I had answered questions correctly or not



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	3	x 3	=	9
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	1	x 5	=	5
TOTAL			11		42

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.82	4	4	0.6	0.36	2

<<Confidence **Tests to see if the student thinks the software gave them feedback on performance in an appropriate manner at appropriate times >>**

23. I felt that the program put me down and made me feel stupid when I made a mistake

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
5	4	3	2	1

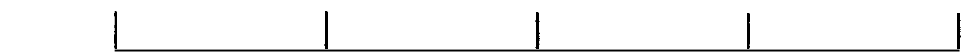
- **There were 11 responses to this question**

Strongly Disagree	(5)	1	x 5	=	5
Disagree	(4)	5	x 4	=	20
Undecided	(3)	3	x 3	=	9
Agree	(2)	0	x 2	=	0
Strongly Agree	(1)	2	x 1	=	2
TOTAL			11		36

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.27	4	4	1.27	1.62	4

<<Confidence **Tests to see if the student thinks the software gave them feedback on performance in an appropriate manner at appropriate times >>**

24. I would like to attempt other lessons in this computer program if I had the chance



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- **There were 11 responses to this question**

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	1	x 3	=	3
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	3	x 5	=	15
TOTAL			11		46

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.18	4	4	0.6	0.36	2

<<Confidence **Test to see if the student is confident in their ability to learn more difficult concepts in the software>>**

25. The time felt like it passed quickly when I was doing the lesson.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- **There were 11 responses to this question**

Strongly Disagree	(1)	1	x 1	=	1
Disagree	(2)	0	x 2	=	0
Undecided	(3)	2	x 3	=	6
Agree	(4)	4	x 4	=	16
Strongly Agree	(5)	4	x 5	=	20
TOTAL			11		43

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.91	4	4, 5	1.22	1.49	4

<<ALL Meta-categories **Test to see how motivational the software is overall. >>**

26. The lessons were fun to do.

Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

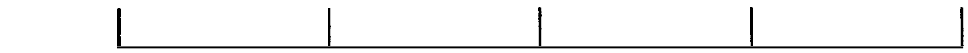
- **There were 11 responses to this question**

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	1	x 3	=	3
Agree	(4)	7	x 4	=	28
Strongly Agree	(5)	3	x 5	=	15
TOTAL			11		46

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.18	4	4	0.6	0.36	2

<<ALL Meta-categories **Test to see how motivational the software is overall. If the software is un-motivating the student will not enjoy the task or will get bored with the tasks >>**

27. I believed everything that the lesson presented to me was TRUE.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

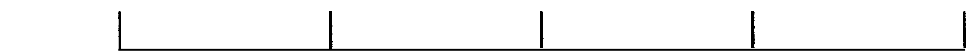
- **There were 11 responses to this question**

Strongly Disagree	**(1)**	**0**	**x 1**	**=**	**0**
Disagree	**(2)**	**0**	**x 2**	**=**	**0**
Undecided	**(3)**	**0**	**x 3**	**=**	**0**
Agree	**(4)**	**6**	**x 4**	**=**	**24**
Strongly Agree	**(5)**	**5**	**x 5**	**=**	**25**
TOTAL			**11**		**49**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	4.45	4	4	0.52	0.27	1

<<Satisfaction **Test to find out student's expectation of what will be learned in the lesson and if the software behaved accordingly>>**

28. The lessons in the program did not rely on the fact that I already knew things about music.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

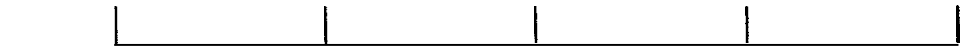
- **There were 10 responses to this question**

Strongly Disagree	**(1)**	**0**	**x 1**	**=**	**0**
Disagree	**(2)**	**2**	**x 2**	**=**	**4**
Undecided	**(3)**	**3**	**x 3**	**=**	**9**
Agree	**(4)**	**4**	**x 4**	**=**	**16**
Strongly Agree	**(5)**	**1**	**x 5**	**=**	**5**
TOTAL			**10**		**34**

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
10	3.4	3.5	4	0.97	0.93	3

<<Satisfaction **Tests student attitude on perceived fairness of the software>>**

29. I prefer doing all schoolwork on the computer.



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

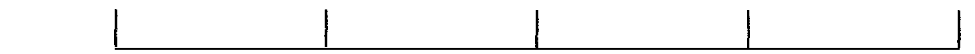
- There were 11 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	1	x 2	=	2
Undecided	(3)	3	x 3	=	9
Agree	(4)	3	x 4	=	12
Strongly Agree	(5)	4	x 5	=	20
TOTAL			11		43

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.91	4	5	1.04	1.09	3

<<Technology Aspects **Test to see if the technology itself is a motivational factor for the student>>**

30. I thought that by being able to talk to another person about the lesson made it more interesting



Strongly Disagree	Disagree	Undecided	Agree	Strongly Agree
1	2	3	4	5

- There were 4 responses to this question

Strongly Disagree	(1)	0	x 1	=	0
Disagree	(2)	0	x 2	=	0
Undecided	(3)	0	x 3	=	0
Agree	(4)	3	x 4	=	12
Strongly Agree	(5)	1	x 5	=	5
TOTAL			4		17

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
4	4.25	4	4	0.5	0.25	1

<<Collaboration Aspects **Tests to see if working collaboratively with another student while using the software was a motivational factor (other than the software itself)>>**

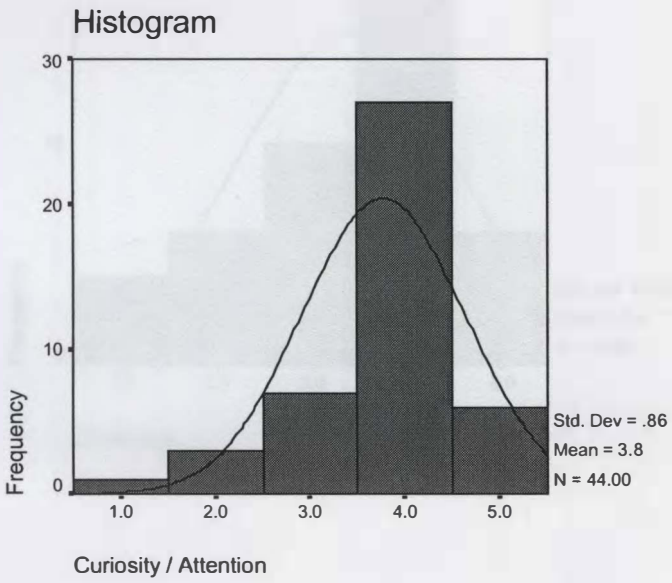
Appendix B2 - Analysis of questionnaire responses by meta-category group

Curiosity/Attention

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
44	3.77	4	4	0.86	0.74	4

- **There were 44 responses to questions in this category**

Response value (1)	**1**	**x 1**	**=**	**1**	
Response value (2)	**3**	**x 2**	**=**	**6**	
Response value (3)	**7**	**x 3**	**=**	**21**	
Response value (4)	**27**	**x 4**	**=**	**108**	
Response value (5)	**6**	**x 5**	**=**	**30**	
TOTAL		**44**		**166 / 220**	**75.5%**

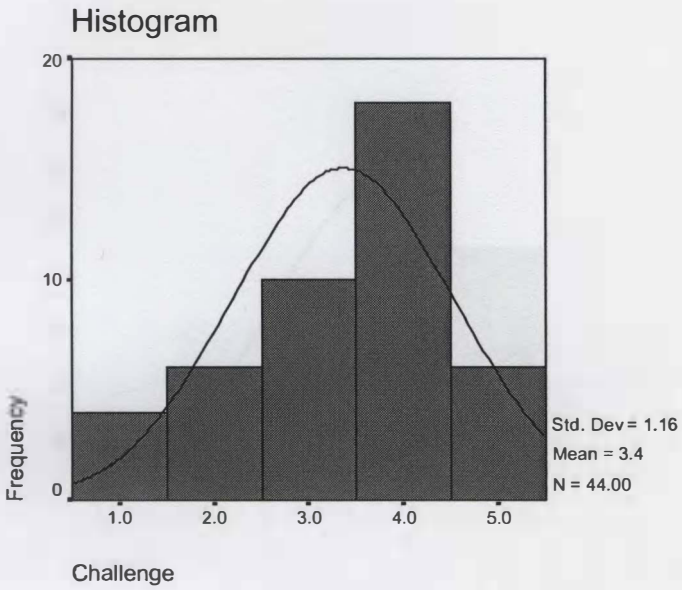


Challenge

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
44	3.36	4	4	1.16	1.35	4

- **There were 44 responses to questions in this category**

Response value (1)	**4**	**x 1**	**=**	**4**	
Response value (2)	**6**	**x 2**	**=**	**12**	
Response value (3)	**10**	**x 3**	**=**	**30**	
Response value (4)	**18**	**x 4**	**=**	**72**	
Response value (5)	**6**	**x 5**	**=**	**30**	
TOTAL		**44**		**148 / 220**	**67.27%**

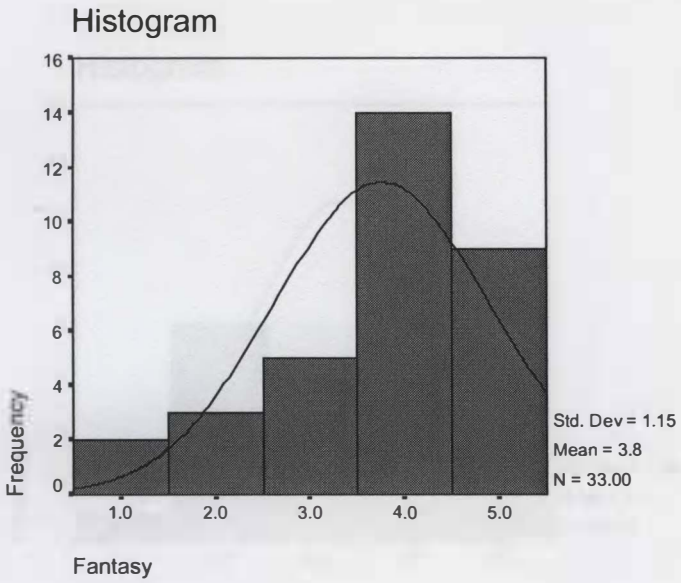


Fantasy

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
33	3.76	4	4	1.15	1.31	4

- **There were 33 responses to questions in this category**

Response value (1)	**2**	**x 1**	**=**	**2**	
Response value (2)	**3**	**x 2**	**=**	**6**	
Response value (3)	**5**	**x 3**	**=**	**15**	
Response value (4)	**14**	**x 4**	**=**	**56**	
Response value (5)	**9**	**x 5**	**=**	**45**	
TOTAL		**33**		**124 / 165**	**75.15%**

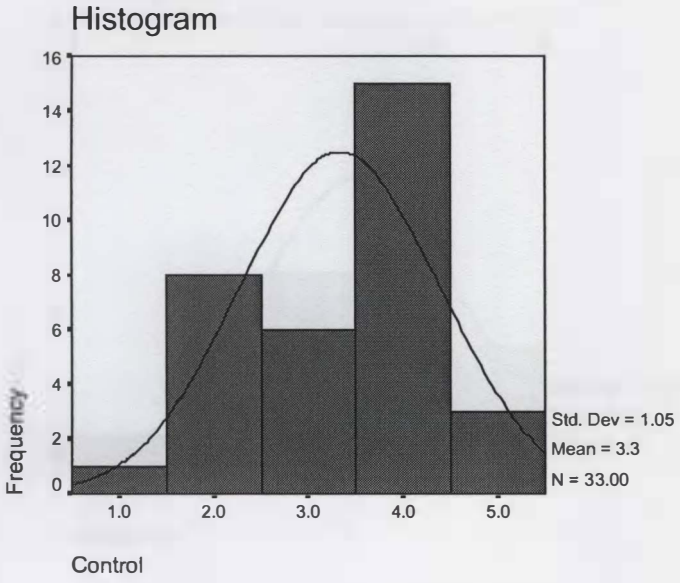


Control

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
33	3.33	4	4	1.05	1.1	4

- **There were 33 responses to questions in this category**

Response value (1)	**1**	**x 1**	**=**	**1**	
Response value (2)	**8**	**x 2**	**=**	**16**	
Response value (3)	**6**	**x 3**	**=**	**18**	
Response value (4)	**15**	**x 4**	**=**	**60**	
Response value (5)	**3**	**x 5**	**=**	**15**	
TOTAL		**33**		**124 / 165**	**66.67%**

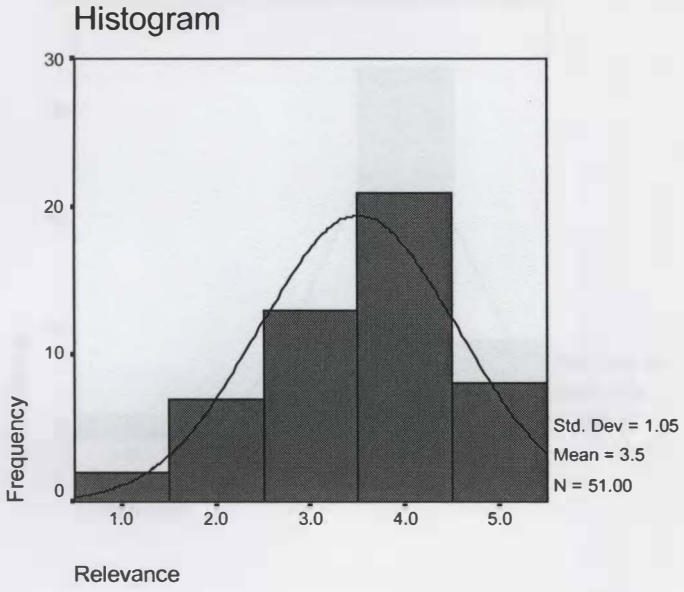


Relevance

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
51	3.51	4	4	1.05	1.09	4

- **There were 51 responses to questions in this category**

Response value (1)	**2**	**x 1**	**=**	**2**	
Response value (2)	**7**	**x 2**	**=**	**14**	
Response value (3)	**13**	**x 3**	**=**	**39**	
Response value (4)	**21**	**x 4**	**=**	**84**	
Response value (5)	**8**	**x 5**	**=**	**40**	
TOTAL		**51**		**179 / 255**	**70.20%**

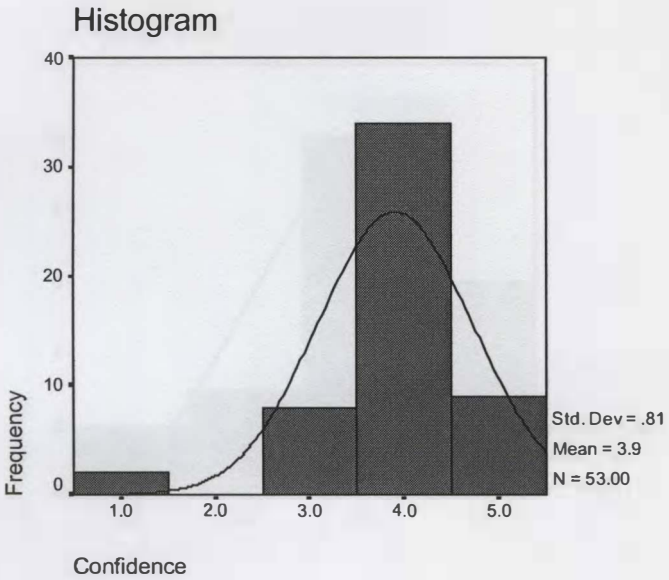


Confidence

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
53	3.91	4	4	0.81	0.66	4

- **There were 53 responses to questions in this category**

Response value (1)	**2**	**x 1**	**=**	**2**	
Response value (2)	**0**	**x 2**	**=**	**0**	
Response value (3)	**8**	**x 3**	**=**	**24**	
Response value (4)	**34**	**x 4**	**=**	**136**	
Response value (5)	**9**	**x 5**	**=**	**45**	
TOTAL		**53**		**207 / 265**	**78.11%**



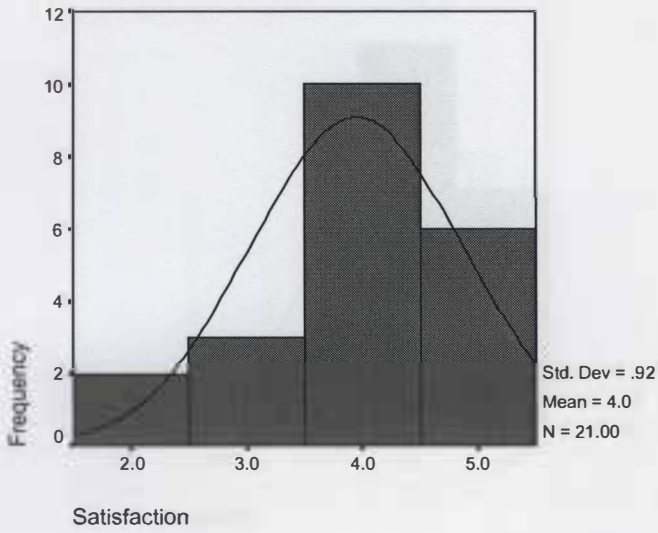
Satisfaction

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
21	3.95	4	4	0.92	0.85	3

- **There were 21 responses to questions in this category**

Response value (1)	**0**	**x 1**	**=**	**0**	
Response value (2)	**2**	**x 2**	**=**	**4**	
Response value (3)	**3**	**x 3**	**=**	**9**	
Response value (4)	**10**	**x 4**	**=**	**40**	
Response value (5)	**6**	**x 5**	**=**	**30**	
TOTAL		**21**		**83 / 105**	**79.05 %**

Histogram

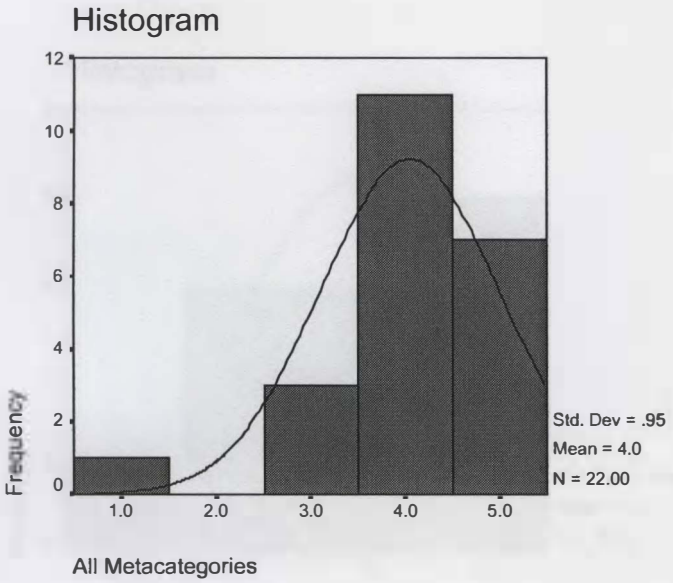


All Meta-categories

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
22	4.05	4	4	0.95	0.9	4

- **There were 22 responses to questions in this category**

Response value (1)	**1**	**x 1**	**=**	**1**	
Response value (2)	**0**	**x 2**	**=**	**0**	
Response value (3)	**3**	**x 3**	**=**	**9**	
Response value (4)	**11**	**x 4**	**=**	**44**	
Response value (5)	**7**	**x 5**	**=**	**35**	
TOTAL		**22**		**89 / 110**	**80.91 %**

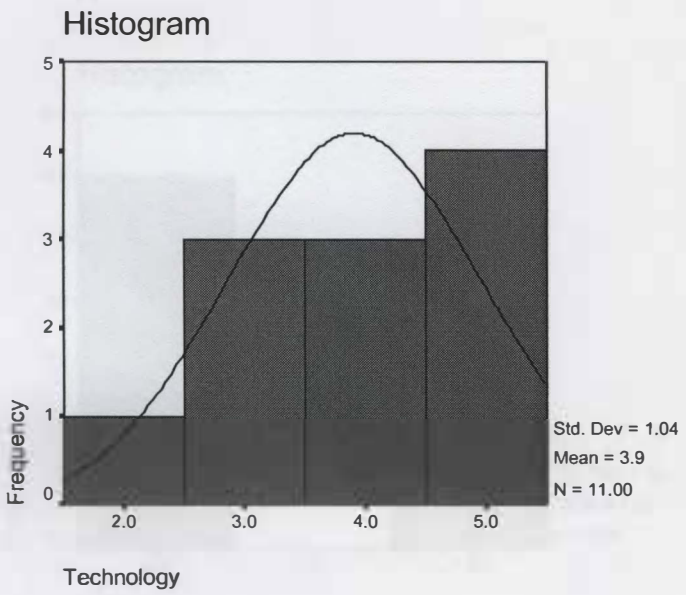


Technology

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
11	3.91	4	5	1.014	1.09	3

- **There were 11 responses to questions in this category**

Response value (1)	**0**	**x 1**	**=**	**0**	
Response value (2)	**1**	**x 2**	**=**	**2**	
Response value (3)	**3**	**x 3**	**=**	**9**	
Response value (4)	**3**	**x 4**	**=**	**12**	
Response value (5)	**4**	**x 5**	**=**	**20**	
TOTAL		**11**		**43 / 55**	**78.18 %**

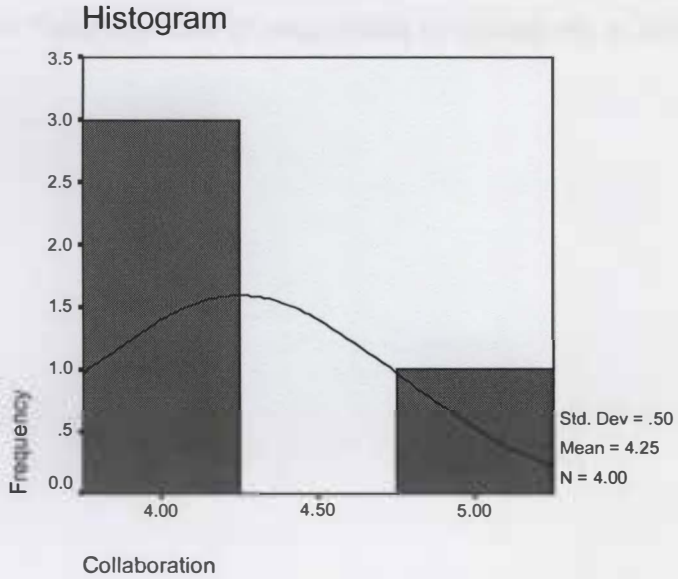


Collaboration

Total Responses	Mean	Median	Mode	Standard Deviation	Variance	Range
4	4.25	4	4	0.5	0.25	1

- **There were 4 responses to questions in this category**

Response value (1)	**0**	**x 1**	**=**	**0**
Response value (2)	**0**	**x 2**	**=**	**0**
Response value (3)	**0**	**x 3**	**=**	**0**
Response value (4)	**3**	**x 4**	**=**	**12**
Response value (5)	**1**	**x 5**	**=**	**5**
TOTAL		**4**		**17 / 20** **85 %**



Descriptives

Descriptive Statistics

	N	Minimum	Maximum	Mean	Std. Deviation
Curiosity / Attention	44	1	5	3.77	.86
Challenge	44	1	5	3.36	1.16
Fantasy	33	1	5	3.76	1.15
Control	33	1	5	3.33	1.05
Relevance	51	1	5	3.51	1.05
Confidence	53	1	5	3.91	.81
All Metacategories	22	1	5	4.05	.95
Satisfaction	21	2	5	3.95	.92
Technology	11	2	5	3.91	1.04
Collaboration	4	4	5	4.25	.50
Valid N (listwise)	4				

N = Total number of responses to questions in category.

Appendix C – Observation findings.

Appendix C1 - Observation (audio tape) - paired group 1

Student	Recorded Dialogue	Discourse Category
Student 1	What do you think you do next?	Procedural
Student 2	I don't know	
Student 1	Does this go here?	Procedural
Student 2	Yeah	
Student 1	This is fun (Comment made on software features)	Social
	Woops	
Student 1	You just click on the picture	Expository
	I can't hear it!	
Student 2	I can't hear it	Expository
Student 1	Do I click on the picture to get to the next one?	
Student 2	Oh, they keep repeating.	
Student 1	8	Explanatory
Student 2	Sorry what did you say?	
Student 1	It's got 8 here – I tried 8	
	1, 2, 3	
Student 2	7! Two are the same colour	
Student 1	I think	Procedural
	You' re going down	
Student 1 & Student 2	(Both reading text from the teapot song aloud – re-iterating the requirement)	Procedural
Student 2	"C", "C"	Explanatory
	"E" – Say "E". "E?"	
Student 1	Yellow – "C" is Yellow	
	Which are these guys meant to be?	
	How do you do this?	
Student 2	Uhm, D is orange, F is Brown, G is Red and the …	
	Not Green! Not Green!	
Student 1	The Green?	
Student 2	Oh, try the Cats.	Procedural
Student 1	Can I do it! Can I do it!	Expository
	Ok, C to E	
	E to B	
Student 2	Start again from the one you finished at.	Expository
Student 1	Go up to C	
Student 2	I think I know how to do it	
Student 1	Forward	Procedural
	Try that one	
	Press "E"	
Student 2	Ok – move forward	
	What? What?	
Student 1	Go down	
Student 2	Did you hear this?	

Student	Recorded Dialogue	Discourse Category
Student 1	Uhm, where is that you start from? Um, I think I know what to do UP! "P" Down	Explanatory
Student 2	Oh no	
Student 1	Ok, that one there How do you make it up – it sounds weird	
Student 2	How do you do red?	Procedural
Student 1	Yep – just put the rest on	Explanatory
Student 2	If you do the same	
Student 1	Don't put them all the same though	
Student 2	Ok, I want to do one	Expository
Student 1	I want to play it Hey, you can put 2 notes here I think	
Student 2	No you can't	
Student 1	That's better	
Student 2	Do you know where to play it from?	Procedural
Student 1	Yes – pres that and press that. Click on that	
Student 2	Play that one again I liked it – It sounded good at the start	Cognitive
Student 1	How do you know? I want to play some of these	
Student 2	Here That's a fun one though! Let me try! Let me try! That will sound funny	
Student 1	Just try it You can play it when you've finished 1 line you know. Try it when you have got 1 line.	
Student 2	Its going to sound funny	
Student 1	Oh, now play it, now play it	

Group 1 - Summary of dialogue by discourse category

Social	1
Procedural	8
Explanatory	4
Expository	5
Cognitive	1

Appendix C2 - Observation (audio tape) - paired group 2

Student	Recorded Dialogue	Discourse Category
Student 1	Yes – the same	Expository
Student 1	Go Back	
Student 1	How do you get to use the paintbrush? (This question was posed to one of the Research Assistants)	Procedural
Student 1	These first, then yellow	Explanatory
Student 2	Those 2 yellow ones?	
Student 2	Yep. Ok – next.	
Student 2	C, D, A.	
	Go Lower	
Student 1	That's a high note	
Student 2	1, 2, 3, 4, 5, 6, 7.	
	Go lower.	
Student 1	What's next?	
Student 2	Go next	
Student 1	What do I do?	Expository
Student 2	From the teapot song.. Yellow Canary and Little Green Bee	
Student 1	What's next?	Cognitive
	There was a green genie….purple demon	
Student 2	"P" is "D"	
	Red Genie is "G"	
Student 1 & Student 2	Green Bee – "B"	
Student 1	Character Eagle is "E"	
	That guy wasn't even in there!	
	Go Back	
Student 2	He is… definitely	
	Look – he has got the blue	
Student 1	No – Go next	
Student 2	Red Genie, Uh, Purple Demon, the Yellow Canary, Green Bee	Expository
Student 1	Positive?	
	What do you reckon it is?	
Student 2	You remember them all?	
Student 1	Remember from what?	
Student 2	Remember that they all had C D AB	
	Oh isn't it like random order?	
	The Green…	
Student 1	Blue was….	
Student 2	Now	
Student 1	Daron, Daron – Concord? (bringing the concord example to Daron, the music teachers attention)	Social
Student 2	Oh yeah – Ok lets move on	Expository
Student 1	This is a simple one.	
	I think you just click next	
	OK … C, E, G	
	OK – now B	
Student 2	Oh B – I'm sure	

Student	Recorded Dialogue	Discourse Category
Student 1	"G?"	Expository
Student 2	G, B, D, F	
	OK – Press G	
	What do we do?	
	F, A, C	
	The one's F, A, C	
	C, E, G	
	Then G, B, D	
	Next… Click on Next	
Student 1 & Student 2	C, E, E, D, B, D, F yeah F again A, C (reciting the notes of an exercise aloud together)	Cognitive
Student 2	No the sound ones, press the sound ones	Expository
Student 1	What? Didn't I do the animals?	
Student 1 & Student 2	C, D, E, F, G, A, B, C, D, E, F, G (Reciting the notes of an exercise aloud together)	Cognitive
Student 2	C, F, A	
Student 1	You can make this box a bit bitter	Explanatory
Student 2	I can't remember what A was	Expository
Student 1	Go next – now go next	
Student 2	"D?"	
Student 1	Which one?	
Student 2	Middle line	
Student 1	First one – Ok down	
	No – up, up!	
Student 2	Up, up!	
Student 1	Down "D"	
Student 2	That's up	
Student 1	Quick go next	
	Yeah OK	
	Yellow	
Student 2	High Red, High Orange	Cognitive
	Low Red, Low Orange	
	Low Red, Low Orange, Low Yellow (creating a composition on a scale from notes in octave)	
Student 2	Ok – I've had enough!	Social
Student 1	I wonder what's to eat today	Social
Student 2	Uhm?	
Student 1	Go in that stave – put it upside down, the highest one	Explanatory
Student 2	And put one next to it. You only have 4	
Student 1	Oh yeah, I forgot about that	
Student 2	Nup, I'll do the bottom 4, you do the top 4	
	The last one	
Student 1	My turn	Cognitive
	It's different with piano – they are just playing right handed and when you play left handed as well you are looking at 2 lines	
	Doing this sounds so strange	
Student 2	I'm going to do a reverse	Cognitive
	Oh go next	
Student 1	No play it first!	
	It worked pretty good	
	We need a low note on the outside	

Student	Recorded Dialogue	Discourse Category
Student 2	Can I do it! Can I do it!	Expository
Student 1	Here, we'll do it with scales	
Student 2	Yes, we'll do it with scales	
	No, do chopsticks!	
Student 1	(Singing the notes aloud as they are composing)	Cognitive
Student 2	Oh, just do the top one	Explanatory
	Now next line – no, now on the line now.	
Student 1	Gee it is an irritating voice (Comment made on software voiceover feature)	Social
Student 2	..And end on "G", on "C" – My turn	Cognitive
Student 1	Wait, keep going, now we want the third line	Cognitive
	Roll on, roll on – no it doesn't matter	
Student 2	Its not getting it	Cognitive
Student 1	No, No – don't worry	
Student 2	High, high, high	
Student 1	Ok, now go click	
	Oh, cool!	
Student 2	End it on "G"	
Student 1	No, end it on a "C", - there!	
Student 2	Yeah, now play it	
Student 1	Here	
Student 2	Yeah, that's good – the speakers	
Student 1	Make it a good one	
Student 2	Leave it! – Now press play	
Student 1	Do we have to finish the whole thing?	Procedural
Student 2	Oh, next – that's enough, there	
Student 1	Either! Either – no green	Explanatory
Student 2	Green?	
Student 1	No red, red – purple	
	OK C, E, G, B, D, F	
	Go next	
Student 2	I want to do this one	Explanatory
Student 1	Go next	
Student 2	Oh, this came up – this is alright?	
Student 1 & Student 2	Hi, Hi (Sight singing their composition together)	Cognitive
Student 1	Next, next, next	Explanatory
Student 2	This isn't even clicking (related to navigation problem with software)	Social

Group 2 - Summary of dialogue by discourse category

Social	5
Procedural	2
Explanatory	7
Expository	8
Cognitive	11

Appendix C3 - Observation (video tape) - paired group 1

Time on wall clock	Student	Observation	Action Interactive	Action Non-Interactive
11:15 1st 10 mins	Student 1	Points to screen and discusses with student 2	Interactive	
	Student 1	Looking at student on PC next to him (distractedly)		*Non Interactive*
	Student 2	Looking around the room (distractedly)		*Non Interactive*
	Student 1	Points to screen	Interactive	
	Student 1	Points to screen	Interactive	
	Student 1 & Student 2	Discussing something about the lesson	Interactive	
	Student 2	Distracted, looking at the PC of the student next to him		*Non Interactive*
	Student 2	Looking around the room		*Non Interactive*
	Student 2	Points to the screen and looking at student 1 and talks to him about it	Interactive	
	Student 2	Points to the screen and looking at student 1 and talks to him about it	Interactive	
1st 10 mins total (%)			**6 (60%)**	**4 (40%)**
11:25 2nd 10 mins	Student 1	Talking with student 2.	Interactive	
	Student 1	Pointing to the screen and attracting the attention of Student 2 to the screen.	Interactive	
	Student 1 & Student 2	Both lean forward towards the PC to hear sounds.	Interactive	
	Student 1	Leaning back in chair – distractedly looking at PC of student next to him		*Non Interactive*
	Student 2	Talks to student 1 to attract his attention back to the PC.		*Non Interactive*
	Student 2	Pointing to screen to show student 1.	Interactive	
	Student 1	Looking around room.		*Non Interactive*
	Student 1	Pointing to screen and talks to student 2.	Interactive	
	Student 1	Points to screen	Interactive	
	Student 1 & Student 2	Students swap seats allowing Student 1 to operate keyboard and mouse.	Interactive	
	Student 2	Pointing to screen and talking with Student 1.	Interactive	
	Student 1	Talking to Student 2	Interactive	

	Student 2	Pointing to screen, talks to Student 1, then looks at PC of student next to him.	Interactive	
2nd 10 mins total (%)			**10 (77%)**	**3 (23%)**
11:35 3rd 10 mins	Student 2	Looks at PC of student next to him.		*Non Interactive*
	Student 1	Talking with student at PC next to him.		*Non Interactive*
	Student 2	Pointing to screen and talking with Student 1	Interactive	
	Student 1	Talking with Student 2	Interactive	
	Student 2	Pointing to screen and talking with Student 1	Interactive	
	Student 1	Talking with Student 2	Interactive	
	Student 1	Pointing to screen a talks to Student 2	Interactive	
	Student 1	Looking around the room distractedly and yawning		*Non Interactive*
	Student 1	Points to screen and talks to Student 2.	Interactive	
3rd 10 mins total (%)			**6 (67%)**	**3 (33%)**
11:45 4th 10 mins	Student 1	Points to screen and talks to Student 2, plus the student sitting at PC next to student 2	Interactive	
	Student 2	Pointing to screen, while student 1 is pointing to screen and talking	Interactive	
	Student 2	Pointing to screen and talking with Student 1.	Interactive	
	Student 1	Talking with Student 2.	Interactive	
	Student 1 & Student 2	Looking at student sitting at PC next to student 1 (who has a problem with his PC).		*Non Interactive*
	Student 1	Talking with student at PC sitting next to student 2.	Interactive	
4th 10 mins total (%)			**5 (83%)**	**1 (17%)**

Appendix C4 - Observation (video tape) - paired group 2

Time on wall clock	Student	Observation	Action Interactive	Action Non-Interactive
11:15 1st 10 mins	Student 1	Talking with Student 2	Interactive	
	Student 2	Talking with Student 1	Interactive	
	Student 1	Points to screen and talks with Student 2.	Interactive	
	Student 2	Points to screen and talks with Student 1	Interactive	
	Student 2	Points to screen and talks with Student 1	Interactive	
	Student 2	Turns to Student 1 and talks to her	Interactive	
	Student 2	Talking to Student 1 while Student 1 points to screen	Interactive	
	Student 1	Looks behind her and asks one of Research Assistants a question		*Non Interactive*
1st 10 mins total (%)			**7 (87.5%)**	**1 (12.5%)**
11:25 2nd 10 mins	Student 1	Turns around and asks Nick a question		*Non Interactive*
	Student 1	Points to screen and talks to Student 2	Interactive	
	Student 2	Points to screen and talks to Student 1	Interactive	
	Student 1	Points to screen and talks to Student 2	Interactive	
	Student 1	Turns to face student 2 and talks to him	Interactive	
	Student 1 & Student 2	Interact verbally	Interactive	
	Student 1	Talking to Student 2	Interactive	
	Student 1	Talking to Student 2	Interactive	
	Student 2	Turns to Student 2 and talks	Interactive	
	Student 2	Talks to Nick		*Non Interactive*
	Student 1 & Student 2	Talking to Daron		*Non Interactive*
	Student 1	Points to screen and talks to Student 2	Interactive	
	Student 2	Pointing to screen and talks to Student 1	Interactive	
	Student 1	Pointing to screen twice and talking with Student 2.	Interactive	
	Student 1	Points to screen and talking to Student 2	Interactive	
	Student 1 &	Talking to Daron (asking him a		*Non*

	Student 2	question about the software).		*Interactive*
2nd 10 mins total (%)			**12 (75%)**	**4 (25%)**
11:35 3rd 10 mins	Student 1	Looks at PC of student sitting next to her		*Non Interactive*
	Student 1	Talking with student 2	Interactive	
	Student 1 & Student 2	Discussing together	Interactive	
	Student 2	Talking with Student 1	Interactive	
	Student 1	Pointing to screen and talking with Student 2	Interactive	
	Student 2	Talking with Student 1	Interactive	
	Student 1	Talking to Research Assistant (asking a question about the software)		*Non Interactive*
	Student 2	Talking to Student 1	Interactive	
	Student 2	Pointing to screen and talking with Student 1	Interactive	
	Student 1	Talking with Student 2	Interactive	
	Student 2	Pointing to screen and talking with Student 1	Interactive	
	Student 1	Talking with Student 2	Interactive	
	Student 1	Turns to Student 2 and talks	Interactive	
	Student 2	Talking to Student 1	Interactive	
	Student 1	Talking with Student 2	Interactive	
3rd 10 mins total (%)			**13 (87%)**	**2 (13%)**
11:45 4th 10 mins	Student 1 & Student 2	Discussing together	Interactive	
	Student 1	Pointing to screen and talking with Student 2.	Interactive	
	Student 2	Pointing to screen and talking with Student 1.	Interactive	
	Student 1	Talking with Student 2.	Interactive	
	Student 1	Talking with Student 2.	Interactive	
	Student 1	Talking with Student 2.	Interactive	
	Student 2	Pointing to screen and talking with Student 1.	Interactive	
4th 10 mins total (%)			**7 (100%)**	**0 (0%)**