

Abstract

This project lies in the field of experience design, a research area of interest to Hewlett Packard Laboratories, Bristol who want to know how to design compelling products. Kidd (2001) has a theory of the compelling experience which has three dimensions: challenge/ self expression, drama/ sensation and social. This model is similar to a theory of intrinsic motivation developed by Lepper & Malone (1987). This theory has several dimensions: challenge, curiosity, control and fantasy and on the social side: co-operation, competition and recognition. Lepper & Malone's (1987) theory states that goal is a motivating feature; this is not stated in Kidd's (2001) theory. The hypothesis of our experiment was that presence of a goal increases motivation. We used Malone & Lepper's (1987) model to design a motivating Soundscape which was used as the task in our experiment. The task was varied along one aspect of Malone & Lepper's (1987) model, that of goal. Then, we attempted to measure the effect this had on the participants' motivation through questionnaires on their perceptions of the task. Our findings support the hypothesis that presence of a goal increases motivation. In particular, in the goal condition participants were more likely to agree that they wanted another go and that they found the soundscape interesting. There was also support of our hypothesis in the comparison questionnaire, a large majority of the participants preferred the goal condition to the non-goal condition. The implications of these findings are that Lepper and Malone's (1987) theory of intrinsic motivation provides a good theory for the design of compelling soundscapes. Although, future research is necessary.

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An Experimental Comparison of Two SoundScapes Based on Malone & Lepper's (1987) Theory of Intrinsic Motivation: Implications for the Design of Compelling Experiences

1. Introduction

Experience design is an emerging field that is interested in the design of compelling experiences. This field is increasingly concerned with emerging digital technologies. Why is there so much interest in designing experiences? From a commercial perspective, HP Laboratories, Bristol are interested in how to design experiences for two reasons. Firstly, they claim that customers choose between products with similar functionality by “*what they say about their owners, what they feel like to use, and where they take you*” (Hull, Reid & Kidd 2002b, p. 3) These last two factors are aspects of user experience. Thus, by attempting to design products which provide compelling experiences, HP are focusing on an aspect of the product which could influence customers' choice of product. The authors go as far as saying that the “*experience gained through a product is of even greater significance than*” “*its ease of use*” (Hull, Reid & Kidd 2002b, p. 3). Secondly, HP are interested in how to design experiences as they claim that in order to deliver ubiquitous computing it is necessary to understand experiences (Hull & Reid 2002a).

We shall now look at two theories of intrinsic motivation/ compelling experiences, which could be used to design compelling experiences. Firstly, we shall present the theory of compelling experiences developed by Hewlett Packard (HP) Laboratories, Bristol. As we have already seen, HP Laboratories are interested in developing a theory of what makes an experience compelling, as they would like to make products that are more compelling. The second theory we shall look at is Malone & Lepper's (1987) theory of intrinsic motivation, a similar theory within the context of learning theory. Malone & Lepper (1987) were primarily interested in “*the design of instructional environments that are intrinsically motivating, that is, environments in*

which people are motivated to learn in the absence of obvious external rewards or punishments” (1987, p. 223). Finally, the similarities and differences between these two models will be discussed.

1.1 Hewlett Packard’s Model of the Compelling Experience (Kidd, A 2001)

HP’s model of the compelling experience (Kidd, A 2001) has three dimensions:

- **Challenge / Self-expression** – the testing of one’s skills or the self-expression of new skills.
- **Drama / Sensation** – the bombardment of our physical senses (sight, sound, touch, smell) and/or the catching of our emotions, imagination and dreams.
- **Social** – This concerns the individual’s relations with other people. This is divided into sense of bonding from a shared achievement or emotion, or the satisfaction of competition i.e. the feeling of superiority of outdoing someone else.

1.1.1 Observational Study

In order to understand what makes an experience compelling, Hewlett Packard carried out various studies. They carried out structured observations of people interacting with 6 popular exhibits at Explore@Bristol. This involved noting occurrences of the following 17 categories of behaviour over a designated period of time:

1. Hanging around the exhibit
2. Queuing to use the exhibit
3. Looking at the exhibit
4. Watching the others use the exhibit
5. Displaying positive emotion in response to someone else using the exhibit
6. Displaying negative emotion in response to someone else using the exhibit
7. Reading the information/instructions

8. Directing someone else's attention onto the exhibit
9. Talking to someone about the exhibit
10. Physically interacting with the exhibit (controlled manner)
11. Physically interacting with the exhibit (random manner)
12. Physically interacting with the exhibit (unorthodox manner)
13. Helping someone else operate the exhibit
14. Restraining someone else from "playing" with the exhibit
15. Using the exhibit to "play" with others
16. Displaying positive emotion in response to the exhibit
17. Displaying negative emotion in response to the exhibit.

Kidd 2001

Discussion groups were also held where participants were encouraged to discuss which exhibits they enjoyed or did not enjoy and why, and what makes a good or bad exhibit.

As part of this research, Hewlett Packard ran an exhibit called Zap Scan in Explore@Bristol, a Bristol science museum. Zap Scan attempted to create something fun and compelling from mainstream technologies (scanning, displaying and printing). Users draw a picture using crayons and paper. Next, they scan this picture onto the system. The picture appears in digital frames on the exhibit. For a pound users may then print their picture and their name onto a glossy card.

People were observed whilst using Zap Scan and asked for feedback on whether they enjoyed the experience. Analysis of the data gathered through the above observational studies, discussions and interviews led to the previously described model of compelling experiences (Hull & Reid 2002).

1.2 Lepper & Malone's (1987) Model of Intrinsic Motivation

The second theory of intrinsic motivation that we will present is that developed by Malone (1981) and Lepper & Malone (1987). Malone (1981) sought to find out what makes things fun to learn and how instruction can be designed in a way that captivates

and intrigues learners as well as educates them. The authors produced a taxonomy of intrinsic motivations for learning, and from this produced design heuristics for the design of intrinsically motivating learning environments (see Appendix 1). This taxonomy is a classification then “*of explanations (or theories) of why people learn without any external rewards or punishments*” (1987, p. 230).

We will now look in more detail at the subsections of this. The first section concerns individual motivation and has 5 subsections.

A1 Challenge – People prefer an *optimal level of challenge*. That is, if an activity is too easy or impossibly difficult, they will not be intrinsically motivated. For an activity to be appropriately challenging to learners, it must provide goals with uncertain attainment. Techniques for making outcomes uncertain include having: variable levels of difficulty, multiple levels of goals, hidden information and randomness. Performance feedback that will improve self-esteem of the individual involved in the activity is also necessary. This should be clear, frequent, constructive and encouraging.

A2 Curiosity – Traditional theories of curiosity propose that curiosity is aroused by “*an optimal level of informational complexity (Berlyne, 1960,1965) or an optimal level of discrepancy or incongruity from present expectations and knowledge (Hunt, 1961, 1965; Kagan, 1972; Piaget, 1951, 1952)*” (Malone & Lepper 1987, p235). The authors argue that curiosity is separate from challenge, one reason being that it does not involve self-esteem whereas challenge does. Curiosity is divided into two types:

Sensory curiosity – This involves changes of sensory stimuli (e.g. sound, light) in the environment attracting attention.

Cognitive curiosity –The authors hypothesise that the individual strives to bring “good form” to their cognitive structures and that environments can activate curiosity by making people believe their current knowledge structures do not have good form. They suggest that completeness, constancy and parsimony are characteristic of such well-formedness.

A3 Control – “The amount of control a person has in a particular environment depends on (a) the range of outcomes the environment provides and (b) the extent to which the probability of each outcome is contingent upon (i.e. can be influenced by) responses available to the person in that environment.” (1987, p. 238). They claim that empowering learning environments are those in which the learner perceives that they have control. That is, environments with lots of choice (probably some optional immediate number of choices exists), whose outcomes depend upon the learner. The authors suggest that a means of harnessing motivation due to perceived control, is to create environments where users’ actions have powerful effects.

A4 Fantasy – Malone & Lepper (1987) define the fantasy environment as “*one that evokes mental images of physical or social situations not actually present.*” (1987, p. 240). The authors distinguish between exogenous and endogenous fantasies. An endogenous fantasy, is one in which there is an integral relationship between the thing being taught and the motivational aspects of the activity. Whereas, an **exogenous** fantasy has an arbitrary link between these two. They hypothesise that endogenous fantasies are more motivating and more educational than exogenous fantasies. **Emotional fulfilment** may be a reason for fantasy being motivational. That is, people can master things unavailable to them in their real world. The authors note that it will be difficult to characterise emotional needs of individuals and note that the kind of fantasies that people enjoy varies greatly. A suggested implication for design, is that if more fantasies are offered, then more people will find the product appealing. Regarding the **cognitive component** of involvement with fantasy, Malone & Lepper (1987) state that endogenous fantasies often provide learner’s with metaphors or analogies, thus helping them apply previous knowledge. The use of fantasy may also improve their memory of the material.

Next we shall look at the **interpersonal motivations** as outlined by Malone & Lepper (1987). These then are theories of ways that interaction with others can produce intrinsic motivation.

B1&B2 Co-operation and competition – For these to take place there must be a goal. In competitive situations one person's gain is another's loss. Whereas, in co-operative situations one person's gain helps the other person. The authors claim that both competition and co-operation can have positive or negative effects. Evidently, they are interested in how to achieve the positive effects on motivation. They hypothesise that endogenous co-operation and endogenous competition will have more positive effects on subsequent intrinsic motivation than their exogenous counterparts. Endogenous competition and co-operation being where the various sub-tasks are dependent on one another. Whereas, exogenous competition and co-operation are where tasks are independent from one another.

B1 Co-operation – Where the tasks are independent, co-operation may be encouraged by combining the scores of two people. The authors predict this to be a weak form of motivation. When the tasks are dependent however, endogenous co-operation may occur.

B2 Competition – With independent tasks, competition may be encouraged for example, by providing individual scores. The authors say that this stimulates initial motivation, but has a negative effect on subsequent motivation. The authors are interested in the notion of endogenous competition. This could be achieved, for example, by allowing players to compete with scores on alternative rounds.

B3 Recognition – This kind of intrinsic motivation involves the enjoyment of others appreciating or recognising one's efforts or accomplishments. In order for this to be possible, the results of one's efforts must be viewable. This can be done by:

- Making visible the process of the activity
- Making visible the product of the activity
- Making visible some other result of the activity.

The authors hypothesise that the motivation for recognition is likely to be stronger where the recognition is endogenous or natural to the activity.

Malone (1981) was interested in the emerging instructional environment of interactive computers. In developing this theory, he analysed the newly founded intrinsically motivating activity of computer games and tried to answer the question “*Why are computer games so captivating?*” (p. 334). This investigation was in the form of a survey and some experiments. These studies led to a preliminary theory of intrinsic motivation which Malone & Lepper (1987) further developed into the theory of intrinsic motivation just described. We shall now look at Malone’s (1981) survey and experiments.

1.2.1 Survey

Malone (1981) interviewed 65 primary school students about their computer game preferences. Participants were Californian students (42 boys and 23 girls) ranging from reception to year 8, although they were mainly younger children. The subjects had been playing with computer games in weekly classes at school for between 2 months and 2 years and were randomly selected for interviews. The procedure was as follows. The teacher provided the experimenters with a list of the 25 games they thought the children preferred the most. Then, each child was asked to rate each of these 25 games on a four-point scale: “*0-never played, 1-didn’t like, 2-liked, and 3-liked a lot*” (p. 341). The order of the games list was randomised.

The main finding of this study was that the most popular games all have a goal and the least popular games do not. Malone (1981) notes that there is a problem with trying to make strong conclusions from this kind of correlational study. That is, it is not possible to know if the factors measured can actually be attributed to the elements stipulated. In order to make stronger inferences, Malone (1981) decided to conduct studies which involve just one game with several versions.

1.2.2 Experiment 1 - Breakout: a sensorimotor skill game

For this experiment Malone (1981) used the game that came out as the most popular in the survey described above, that is Breakout. Figure 1 shows a screenshot of Breakout. The player controls the paddle on the left to bounce the ball against the wall of

bricks on the right. Each time the ball bounces off the wall it destroys a brick and adds to the score, the aim of the game being to knock out all of the bricks.

Figure 1

Screenshot from Breakout (Malone 1981 p. 345)

In order to discover which features of Breakout make it so attractive to children Malone (1993) produced different versions of the game by modifying the three main elements of the game:

- the score,
- the breaking out of the bricks, and
- the ball bouncing off the paddle.

Thus, he created 6 different versions of Breakout by varying these three factors (see Figure 2).

Figure 2:

Different versions of Breakout (Malone 1981 p. 347)

Version 1: Features: Score keeping, bricks breaking, ball bouncing (the original game)
The ball keeps going until the player misses it. There are five balls per game. Each brick scores the number of points at the bottom of that column.

Version 2: Features: Score keeping, no bricks breaking, ball bouncing
The ball keeps bouncing between the paddle and the bricks without breaking any bricks. A point is added to the score for each bounce.

Version 3: Features: Score keeping, no bricks breaking, no ball bouncing
The ball does not bounce off the paddle, it is 'caught' by the paddle. A point is given for each catch.

Versions 4,5 and 6 are the same as versions 1,2 and 3 respectively, but have no score.

Version 4: Features: No score, bricks breaking, ball bouncing (the original game without score keeping)

Version 5: Features: No score, no bricks breaking, ball bouncing

Version 6: Features: No score, no bricks, no ball bouncing

The results showed the original version to be the most fun. It was found that the most important feature in determining whether the game is liked is the breaking out of the bricks. The bouncing from the paddle and the score are approximately equal to each other in importance, but less important than breaking out the bricks.

Malone's (1981) finding suggests that possible reasons for this are that the breaking bricks provide a "*visually compelling fantasy goal*" (p. 348) and a graphic score-keeping device. The authors note that versions with no goal (i.e. with no score or

bricks breaking) were considerably less appealing, thus emphasising the need for a goal in a game.

1.3 Comparison of Lepper & Malone's (1987) Model of Intrinsic Motivation and Hewlett Packard's (2001) Model of the Compelling Experience

The two models just presented (that is, HP's model of a compelling experience and Malone & Lepper's model of intrinsic motivation in learning environments) seem very similar. This will now be looked at in more detail (see Table 1).

Many similarities do exist between the two models. Both models cover the following aspects: **challenge, fantasy, sensory curiosity, co-operation and competition**. However, there are also many differences between the two models. Many of these differences are due to Malone & Lepper's (1987) model being more detailed, even with regards to components that are shared across the two models. Another general difference is that Malone & Lepper (1987) provide a framework to help designers implement their theory in design. Whereas, HP provides a model only, with no suggestion as to how to apply it in design. Malone & Lepper (1987) explicitly state this: *"We are particularly interested with making distinctions and formulating principles that can be used in designing intrinsically interesting learning environments, not just in explaining why or predicting that some environments will be more interesting than others."* P. 224. Whereas, HP's model is still being developed, thus, there are no suggestions for design at this stage.

Table 1:

Comparison of Lepper & Malone's (1987) Model of Intrinsic Motivation and Hewlett Packard's (2001) Model of the Compelling Experience (equivalent components shown where they exist):

What are the more specific differences between the models? There is no explicit mention of creativity in Lepper & Malone's model. However when describing challenge types, they distinguish two types of goal: fixed goals and emergent goals. A fixed goal is predetermined whereas an emergent goal arises from the interaction between the person and the environment. Also, when specifying fantasy, they note that the fantasies that appeal to individuals vary a lot. One implication of this is: "*...[that] one might also create fantasy environments into which students can project their own fantasies in a relatively unconstrained way.*" P. 241. Perhaps, these descriptions cover creativity in an indirect way.

A second difference between the models is that the fantasy component is described in more detail by Lepper & Malone (1987), (that is, it includes a distinction between exogenous and endogenous fantasy and mentions cognitive and emotional aspects of fantasy).

A further dissimilarity between the models is the inclusion of control and cognitive curiosity by Lepper & Malone (1987). These concepts are absent from HP's model.

Both models include social / interpersonal aspects, HP's model includes the "*intense sense of bonding arising from a moment of shared achievement or shared emotion, or from the sense of superiority over others which comes from out-performing them in a competitive exercise*" (Kidd, 2001, p.18). This corresponds to the notions of co-operation and competition as found in the social element of Malone & Lepper's model. Malone & Lepper further refine co-operation and competition, and add another kind of social motivation, that of recognition.

2. Research Question

An interesting difference between Malone & Lepper's (1987) and Kidd's (2001) theories of intrinsic motivation concerns 'goal'. Malone & Lepper's (1987) theory explicitly states that an appropriate goal causes motivation, whereas Kidd's (2001) theory does not. This difference is also interesting because Malone found in his studies that having a goal was an important factor in making an experience compelling or intrinsically motivating. I have chosen to base the design of an experience on Malone & Lepper's (1987) theory. The experiences will be two soundscapes which will differ depending whether they have a goal or not..

Therefore, the aim of this study is to investigate the effect of having a goal on intrinsic motivation. The study is designed to test the hypothesis that intrinsic motivation is higher when an experience has a goal.

Thus, it is expected that the soundscape that includes a goal will be a more compelling experience than the soundscape that does not. Compelling experience will be measured by using a questionnaire on the children's preference and interest.

3. Method

3.1 Design

The experiment was a within subjects design. The independent variable was presence or absence of a goal within the soundscape; in one condition the soundscape had a goal and in the other condition the soundscape did not have a goal. The dependent variables were the children's perceptions of the tasks, these were measured using a questionnaire.

3.2 Participants

Overall there were 24 participants, 18 male and 6 female. They were Year 7 students (that is, aged 11 –12) from St Gregory's School, Bath. The pupils were selected by the school and were told that they would be spending a day at HP Labs. They were not told what they would be doing at HP.

3.3 Apparatus and Materials

The main equipment used was the soundscape, a technology used at Hewlett Packard Laboratories, Bristol (HP Labs). A soundscape is a physical environment that is overlaid with digital aura.

An aura is defined by several properties:

- *“A unique identifier, a channel assignment, and a name*
- *A location and the radius of a circle of applicability around that location.*
- *The URL of the audio object associated with the aura*
- *Whether the audio should be looped on completion.”* (Hull, Reid & Kidd, 2002b p. 10),

Figure 3 shows an example of a map of the floor plan of the physical space with audio auras mapped on to it.

Figure 3

A Plan View of the Audio Auras Mapped onto the Physical Space

The location of the user in the physical space is sensed by means emission of pulses from an RF transmitter and from ultra sonic transmitters strung above the physical space which are received by the wearable computers. Depending which ultrasonic transmitters are in the range of the computer, the computer identifies where it is to within 15cm.

The default behaviour of the aura is to act as a switch, so when a user enters a region of applicability of an aura, their client device (*“a HP Jornada PocketPC with a compact flash LAN card and a small extension board to interface to the location sensing infrastructure”* carried in a small shoulder bag and with headphones) immediately fetches and plays the audio specified by that aura’s URL. It does this via the 802.11b wireless network installed in the building. It is possible for the user’s device to play all audios associated with overlapping auras simultaneously. It is also possible to set channels up with different behaviours. For example, in a past soundscape (a digitally enhanced walk in the woods) the auras in the green channel (see Figure 3) were used to trigger wolf growls to encourage users back into the main area of the soundscape. However, if the user had already encountered a certain number or above of the main auras the growling would not occur. This is an example of the possibility of encoding special aura behaviour based on users history (i.e. where they have already been in the soundscape) into the client device (Hull, Reid & Kidd 2002b). Another example of special aura behaviour is the possibility of encoding a switch from one map to another. Thus, the user enters a particular aura and the whole digital map changes to another map.

The different colours of the aura in Figure 3 represent different ‘channel assignments’. These channels are a way of labelling the aura type for the designer and the system.

The physical elements of the soundscape were yellow material, an inflatable alien, a fairy costume, a transistor radio, a table, a mock compass (sheets of paper with ‘N’, ‘S’, ‘E’ and ‘W’ marked on them), green material and a plant.

A second piece of equipment used was a video camera and tripod.

Finally, materials used were questionnaires and pencils. The questionnaire was derived from Malone & Lepper’s (1987) theory of intrinsic motivation. The aim of the questionnaire was to gather data about three issues:

- Whether the goal version was perceived to have a goal;
- Which components of Malone and Lepper’s (1987) theory were present in the soundscapes;
- The participant’s attitude towards the soundscape, in particular their level of motivation.

There were three questionnaires. Questionnaire 1 consists of three sections, a set of questions using a five-point Likert scale, a closed question and three open-ended questions. This questionnaire initially uses 11 questions using a five-point Likert scale with end points of 1 (strongly disagree) and 5 (strongly agree) – see Figure 4. Thus, statements are presented and the participant must chose one of the following: ‘Strongly disagree’, ‘disagree’, ‘neutral’, ‘agree’ or ‘strongly agree’.

Figure 4

Questionnaire 1: Goal Condition Version

Name: _____

For the following statements please say whether you Strongly disagree, disagree, feel neutral, agree or strongly agree.

1. I thought the sound scape was too easy

Strongly disagree Disagree Neutral Agree Strongly agree

2. I felt sure that I would get the three keys to the transistor radio in the time given

Strongly disagree Disagree Neutral Agree Strongly agree

3. I received clear feedback on how I was doing

Strongly disagree Disagree Neutral Agree Strongly agree

4. I would have liked more feedback

Strongly disagree Disagree Neutral Agree Strongly agree

5. The soundscape was very interesting

Strongly disagree Disagree Neutral Agree Strongly agree

6. I knew what to do

Strongly disagree Disagree Neutral Agree Strongly agree

7. I like comparing what I was doing compared to my friends

Strongly disagree Disagree Neutral Agree Strongly agree

8. I worked with my friends

Strongly disagree Disagree Neutral Agree Strongly agree

9. I did like the fact that others could see what I was doing

Strongly disagree Disagree Neutral Agree Strongly agree

10. I would like another go of this soundscape

Strongly disagree Disagree Neutral Agree Strongly agree

11. I found the island fantasy interesting

Strongly disagree Disagree Neutral Agree Strongly agree

12. How many keys did you get to the magic transistor radio?

13. What did you like about the soundscape?

14. What did you dislike about the soundscape?

15. How could the soundscape be more compelling?

15. Are you male or female?

These statements cover various aspects of the design of the soundscape. Firstly, there were statements to check that the goal version was indeed perceived to contain a goal, the level of challenge the goal provided and whether there was appropriate feedback relating to the goal. That is, to verify that the IV (goal) was present and in an appropriate form (see questions 1-4 & 6, Figure 4). Secondly, there were statements designed to check for the presence of other elements of the model of intrinsic motivation: that is, whether they liked the fantasy used in the soundscapes, whether there was any interpersonal motivation (competition, co-operation and recognition) (see questions 7-9 & 11, Figure 4). Thirdly, there were statements regarding whether the soundscape was compelling. These asked whether the soundscape was interesting and if they would like to repeat the experience (see questions 5 & 10, Figure 4).

Following these questions, there was a question asking how far the participant had proceeded towards achieving the goal of the soundscape, that is, how many keys they had brought to the transistor radio. Finally, there were three open-ended questions. These asked if there was anything the participant liked or disliked about the soundscape and how they think it could have been made more compelling.

Questionnaire 2 – non-goal condition was the same as questionnaire 1, but the questions relating to the goal were removed (that is, questions 1-4 & 12, Figure 4).

Questionnaire 3 – comparison of the two conditions, Figure 5 - incorporated a closed question asking which version was preferred and an open-ended question asking why they preferred it.

Figure 5

Questionnaire 3: Comparison of the Two Versions of the Soundscape

<p>Which soundscape did you prefer?</p> <table border="1"><tr><td>First</td><td>Second</td></tr></table> <p>Why?</p> <hr/> <hr/> <hr/>	First	Second
First	Second	

3.4 The Task

The tasks were two soundscapes that had been designed and constructed specifically for the experiment using HP's designated software. As previously mentioned, one soundscape had a goal and the other soundscape was goal-less.

Two year 10 students acted as stand in end users during the design phase, thus making the theme of the soundscapes more appropriate to the specific age group of the end users.

3.4.1 Goal Version

The 'goal version' of the soundscape (see Figure 6) was a game, the goal of which was to get three keys from an island to give to a magic transistor radio in order to save his friend Fifi fairy from wrongful imprisonment. In order to do this, the user gets instructions from the transistor. Next, they pick up magic dust from Fifi fairy, by standing in the relevant location, and she explains that the dust enables them to find invisible stepping stones. Next, they try to find the first stepping stone. Once they have found this stepping

stone, they are given a code which helps them to calculate where the next stone is, North, South, East or West. If in attempting to find a subsequent stepping stone they miss and stand in the location of the water aura, they lose their dust and must return to Fifi to get some more and start to cross the water again. If they successfully reach the island they are told that they have a key and to return to the transistor. When they reach the transistor radio with a key, this prompts the changing of the audio map. Thus the map changes to Map 2 (see Figure 7) and they are given instructions for the second key. Notably, the path of the stepping stones gets more difficult with each level, the third level is thus the hardest (see Figure 8). The goal of this soundscape is to reach the island three times and bring three keys back to the transistor radio.

Figure 6

Map of the Soundscape in the Goal Condition (Level 1) Annotated with Description of Audio of Each Aura

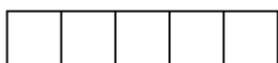
Figure 7

Map of the Soundscape in the Goal Condition (Level 2): NB Content of the Audio Changes With Each Level

Figure 8

Map of the Soundscape in the Goal Condition (Level 3): NB Content of the Audio
Changes With Each Level

The nature of the soundscape aura was modified in order to enable us to build our soundscapes. It was made possible for an aura to have an area of applicability in a square shape. The presence of gaps between stepping-stones would be undesirable, as it would make it difficult to step from one stone to the next without stepping in the water. Thus, the square aura were used for the stepping stones so that they would not have gaps between one another as they would tessellate. That is, the stepping stones would look for example, like this:



Instead of like this:



Also, a token system was implemented. Certain auras instigate the picking up of a token in the client device, other auras induce the collecting of tokens from the client device. Thus, it was possible to have conditions on certain aura; if the client device had a certain number of tokens it would behave in one way, if it did not it would behave in another way. This token system was used to necessitate the user to get fairy dust in order to locate a stepping stone and to find the first stepping stone before the second stepping stone and so on up to the island. This was done by the user's computer picking up a token at the Fifi area and picking up an extra token on each subsequent stone. If they walked into the water area the token number would be set back to zero. Thus, they would have to get some more dust. If the user collects all the tokens (the final one being at the island) and returns to the transistor, it changes the map to the next level and resets the token counter to zero. Apart from on the third level when the game finishes at this point.

The physical element of the soundscape (see Figure 9) consisted of yellow material to mark the beach, a suspended inflatable alien dressed as a fairy, a transistor

radio on a table, a compass marked on the sea area, and green material and a plant to represent the island.

Figure 9

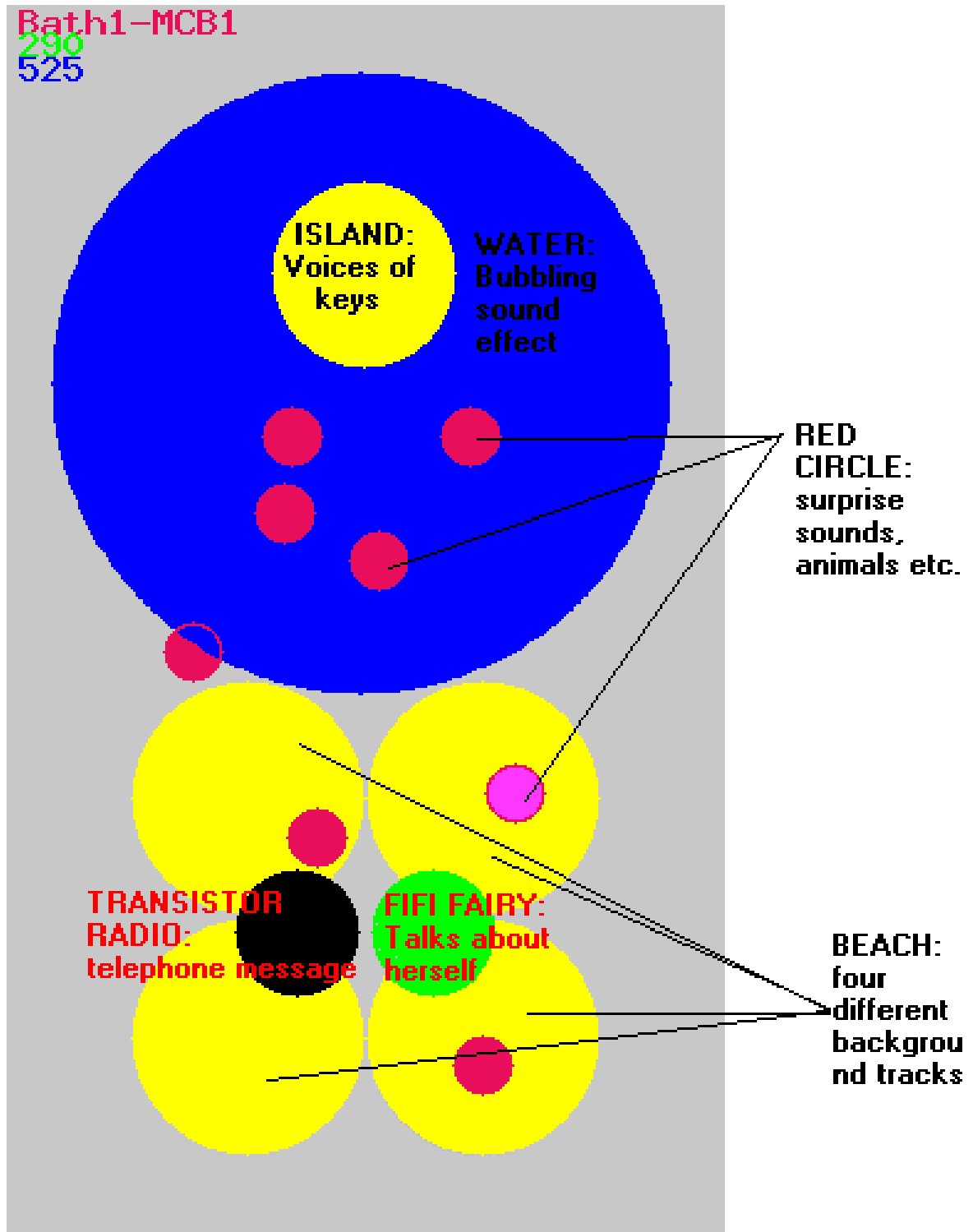
Physical Layout of the Soundscapes Used in the Experiment

3.4.2 The Non-goal Version

The Non-goal version was a soundscape that contained all the elements of the goal version apart from the goal. Thus, it was exactly the same physically (see Figure 9) as the goal version. The audio for Fifi fairy, the magic transistor radio, the land and water were similar to those used in the goal version but not the same. For example, where there were voices used they were the same, but they said different things. Where there was background music, it was replaced by similar sounds. The element of surprise found in the game version was replaced by having surprise auras dotted around the soundscape, these contained animal sounds (see Figure 10).

Figure 10

Map of the Soundscape in the Non-Goal Condition Annotated with Description of Audio of Each Aura



3.5 Pilot Test

Once a prototype was built, it was tested by eight adults (adults were used instead of children as they were more easily available). Their answers to the questionnaire along with their verbal feedback allowed us to improve the soundscape. The main problem highlighted was a technical one; the foliage around the physical soundscape was interfering with the audio next to it, meaning that the sound cut out frequently in certain areas. The problem was resolved by moving these parts of the soundscape towards the centre of the space, thus increasing their reliability. Other problems highlighted included the need to reposition Fifi the fairy closer to the water so as to reduce the tediousness of having to return to her every time the magic dust has been washed off. The goal version was shown to be extremely challenging; only one participant completed the game and this took 25 minutes. The questionnaire proved to be a useful tool, both for the evaluation of the use of the soundscape as a game and for measuring people's attitudes.

3.6 Procedure

Prior to arrival of the participants, the physical element of the soundscapes was set up (see Figure 9) and a video camera was placed looking down on the soundscape. The 29 children visited HP Labs with their teachers for the day. Whilst they were not doing the experiment they were either having a tour of the Labs, a general talk about HP or having lunch with a lunch activity of discussing possible uses for context aware computing of the future (see Appendix 2).

Each group of 10 participants was divided into two groups of five, so that the soundscape was not too crowded to use. Each group was given standardised instructions prior to starting their first soundscape, these explained what a soundscape is, that they would be experiencing two soundscapes and answering questionnaires on them and finally that they could withdraw from the experiment at any time. They were also given standardised instructions before each soundscape and each questionnaire, in particular it was emphasised that the questionnaire was to gather their opinions and was definitely not

a test (see Appendix 3). The first four groups started with the goal condition. The last two started with the non-goal condition. Each participant was given 10 minutes on their first soundscape and 10 minutes to fill in the relevant questionnaire. Then they were then given 10 minutes on their second soundscape followed by the relevant questionnaires. Thus, at the end of the data collection period of three hours, each individual had filled in a questionnaire on the goal version of the soundscape and a questionnaire on the non-goal version of the soundscape and a questionnaire comparing the two.

4. Results

The results collected through the soundscape specific questionnaires will now be presented followed by the data gathered in the comparison of conditions questionnaire.

4.1 Results of the Non-goal and Goal Condition Questionnaires

4.1.1 Questions Using a Likert Scale

The results of the questions using the Likert scale are summarised in Table 2. The Mean and the Standard Deviation is presented for each question in each condition. These results were analysed using a one way ANOVA with an Alpha level of 0.02. The results of this analysis are also summarised in Table 2 in the form of F and p.

There were four statistically significant differences between the two conditions found through this analysis. The most striking difference concerned whether the participant wanted another go of the SoundScape – Question 10 – ($F(1, 23) = 6.41, p < 0.005$). In the goal condition the participants were more likely to want another go compared with the non-goal condition.

There was a significant difference between the conditions in answering question 5, “The SoundScape was very interesting.” – ($F(1, 23) = 6.4, p = 0.02$). Participants in the goal condition thought the soundscape was more interesting than in the non-goal condition.

Table 2

Summary of Participants' Ratings on a Five-point Likert Scale of Agreement with Six Statements in Both Conditions.

Question	Goal		Non-Goal		F	p
	M	SD	M	SD		
Question 5: "The SoundScape was very interesting."	3.9	0.9	3.3	1.2	6.4	0.02
Question 6: "I knew what to do."	3.3	0.9	2.9	1.3	4.1	0.06
Question 7: "I like comparing what I was doing compared to my friends."	3.5	0.5	3.4	1.1	0.3	0.59
Question 8: "I worked with my friends."	3.0	1.1	3.8	1.0	6.7	0.02
Question 9: "I did like the fact that others could see what I was doing."	3.5	0.7	3.5	1.0	0.1	0.71
Question 10: "I would like another go of this SoundScape."	4.3	0.8	2.8	1.5	23.9	0.00
Question 11: "I found the island fantasy interesting."	3.9	0.8	3.4	1.1	4.6	0.04

Note: 1 = Strongly disagree; 2 = disagree; 3 = neutral; 4 = agree; 5 = strongly agree

M = Mean; SD = Standard Deviation

n = 24

Participants opinions on whether they worked with their friends whilst using the SoundScapes – Question 8 – also varied significantly according to the condition. ($F(1, 23) = 6.66, p = 0.02$). Participants thought that the experience was sociable when in the non-goal condition, compared to the non-goal condition.

There was also a significant difference in terms of question 11, “I found the island fantasy interesting” – ($F(1, 23) = 4.6, p = 0.04$). Participants thought that the fantasy used in the goal condition was more interesting than the fantasy used in the non-goal condition. In the goal condition, on average participants were in weak agreement that they knew what to do. Whereas, in the non-goal condition they were on average in weak disagreement with this statement.

There were no significant differences across conditions for question 6 (I knew what to do), question 7 (I liked comparing what I was doing compared to my friends) and question 9 (I did like the fact that others could see what I was doing).

4.1.2 Open-Ended Questions

Participants were also invited to respond to three open-ended questions asking for their opinions on, which elements of the soundscapes they liked and which they disliked, and how the soundscapes could be made more compelling.

The answers to these questions were then coded using a categories based on Malone & Lepper’s (1987) theory of intrinsic motivation. The following are the categories used, they clearly relate to Malone & Lepper’s (1987) theory (see introduction).

- Goal
- Level of challenge
- Amount of variation
- Level of clarity (i.e. suitability of the instructions or of the feedback)
- Freedom of participant

- Fantasy
- Competition
- Collaboration
- Recognition
- Cognitive curiosity about the Technology
- Sensory curiosity – Sounds, vision, etc.

There were also a number of other categories.

- Problems with Technology

This was a category which covered problems with the technology, as participants frequently commented on these. For example, “sound flickers”, P4, and “if you stepped out of the area of the computer talking and back in it would reset”, P12.

- General Positive and Negative Comments

It was also necessary to add categories for general positive comments and general negative comments. These covered statements such as “It was boring”, P16, which do not specify how or which element of the soundscape caused it to be boring or interesting.

- Other

This category was covered blanks and where the participant stated “Nothing”, and suggestions that virtual glasses should be added.

The complete list of coding categories used in coding the open-ended answers is shown in Appendix 4. A copy of the answers to these open-ended questions annotated by this code is in Appendix 5.

Table 3 shows the frequency with which each category was mentioned in response to question 13 (What did you like about the soundscape?) in the goal and non-goal condition. Interestingly, participants mentioned goal 5 times in the goal condition, as opposed to zero times in the non-goal condition. These comments typically stated that

they liked the goal, for example “[The thing I liked about the soundscape was that] There was a task”, P18. Also, participants made general positive comments more than twice as often in the goal condition as in the non-goal condition. Also, they referred six times more to elements of cognitive curiosity in the goal condition. For example, in the goal condition, P4 displayed curiosity about the functioning of the system when he stated “the radio gave you feedback on where you were in the map. It was very clever.”. In the non-goal condition, participants referred 18 times to elements of sensory curiosity (sound and vision), more than twice as much as in the non-goal version. For example, P6 stated “I liked the do-bee-doo music and the animal sounds.”

Table 3:

Frequency of Categories Used in Response to Question 13 (What did you like about the soundscape?) of the Condition Specific Questionnaires

Category	Frequency	
	Goal Condition	Non-goal Condition
Goal	5	0
Challenge	0	1
Variation	0	0
Clarity	0	0
Freedom	0	2
Fantasy	2	3
Competition	0	0
Collaboration	0	0
Recognition	1	0
Cognitive curiosity	6	1
Sensory curiosity	8	18
Technical problems	0	0
General Negative	0	0
General positive	7	3
Other	2	0

Table 4 shows the frequency that each category was used in the goal and non-goal conditions in response to question 14 (“What did you dislike about the soundscape?”). Notably, there were 5 general negative comments about the non-goal version, whereas, there were none about the goal version. Individual elements of both soundscapes were singled out as being disliked. In the non-goal version lack of variation (i.e. where there is not enough to do) was cited to be disliked 8 times as opposed to zero times for the goal version. A typical comment categorised thus is the following: “After you heard everything there wasn’t much to do”, P3. Concerning the goal version, various elements were disliked. The two main categories used, with 10 citations each (as opposed to only two each in the non-goal condition), were technical problems and level of clarity.

The issue of goal was broached in two different ways. Firstly, it was mentioned twice that lack of goal was a disliked element of the non-goal version. Secondly, the level of challenge the goal provided was presented three times as being disliked in the goal version. That is, participants stated the level of challenge was too difficult.

Table 4:

Frequency of Categories Used in Response to Question 14 (What did you dislike about the soundscape?) of t
Condition Specific Questionnaires

Category	Frequency	
	Goal Condition	Non-goal Condition
Goal	0	2
Challenge	3	0
Variation	0	8
Clarity	10	2
Freedom	0	1
Fantasy	2	2
Competition	0	0
Collaboration	0	0
Recognition	1	0
Cognitive curiosity	0	0
Sensory curiosity	0	1
Technical problems	10	2
General Negative	0	5
General positive	0	1
Other	3	5

Table 5 shows the frequency of categories used in response to question 15 (“How could the soundscape be more compelling?”) in both conditions. In answer to this question in the non-goal condition, the most frequently used category was sensory curiosity. A typical example of a comment categorised as sensory curiosity is, “put more sounds in it”, P18. The next most used category was goal, which was mentioned nine times. Participants generally stated that there should be a goal. In both versions of the soundscape they suggested more variation was needed. For example, one participant suggested the soundscape could be improved “if there was something else to do”, P2. Areas highlighted for change in the goal version were the level of clarity and technical problems. Changes suggested for the goal version which fell in the ‘other’ category included 6 participants mentioning the possibility of including virtual glasses as part of the system.

Table 5:

Frequency of Categories Used in Response to Question 15 (How could the soundscape be more compelling?) of the Condition Specific Questionnaires

Category	Frequency	
	Goal Condition	Non-goal Condition
Goal	0	9
Challenge	2	0
Variation	6	6
Clarity	5	0
Freedom	0	0
Fantasy	5	0
Competition	0	0
Collaboration	0	0
Recognition	0	0
Cognitive curiosity	1	1
Sensory curiosity	1	12
Technical problems	4	0
General Negative	1	1
General positive	0	1
Other	10	4

4.1.3 A Goal Condition-Specific Question

Participants were asked how many levels they had completed in the goal condition. The average was 0.8 out of three levels.

4.2 Results of the Comparison Questionnaires

4.2.1 Which SoundScape was Preferred?

The comparative questionnaires gathered data concerning which soundscape was preferred (goal or goal-less) and why this was the case. Table 6 shows the number of participants who preferred the goal version and the number of participants who preferred the non-goal version. Ninety-six percent of participants chose the goal version as their preferred soundscape.

Table 6

Participants' Preferred Soundscape

Version of Soundscape	Goal	Non-goal
Number of participants preferred by	23	1

4.2.3 Reasons for this Preference?

Participants were asked why they preferred the soundscape they had chosen. These responses were coded using the previously identified categories (see Appendix 4 for coding categories and Appendix 6 for coded data). Table 7 shows the frequency of categories used by the 23 participants who said they preferred the goal version of the soundscape and for the one participant who preferred the non-goal version of the soundscape. One participant preferred the non-goal version because the goal version lacked clarity. The goal version was preferred for many reasons. The most common reason which was mentioned 9 times is the presence of a goal. Examples of the ways in

which this was expressed include “you had something to do”, P3; “it had a target” P7; “there was a task”, P18. Other common reasons included the amount of variation, for example “there was more to do”, P3; and the level of challenge.

Table 7:Frequency of Categories Used in Response to Question 16: Why (did you prefer the goal/non-goal version)?

Category	Frequency	
	Goal Condition (n=23)	Non-goal Condition (n=1)
Goal	9	0
Challenge	3	0
Variation	6	0
Clarity	0	1
Freedom	1	0
Fantasy	0	0
Competition	0	0
Collaboration	0	0
Recognition	0	0
Cognitive curiosity	0	0
Sensory curiosity	0	0
Technical problems	0	0
General Negative	0	0
General positive	5	0
Other	2	0

5. Discussion

5.1 Summary of Findings

There were significant differences between the goal condition and the non-goal condition. In the goal condition, participants were significantly more likely to find the soundscape and the island fantasy interesting and to want another go of the soundscape. In the non-goal condition, participants claimed they worked with their friends significantly more than in the goal condition. There was no significant difference across conditions for the following variables: awareness of what to do, comparison of self with friends, enjoying being watched by others.

Elements that the participants liked about the goal version of the soundscape were the presence of a goal and the nature of the technology used. They made twice as many general positive comments about the soundscape in the goal condition as compared to the non-goal condition. Aspects of the soundscape liked by the participants in the non-goal condition related to sensory curiosity, that is, to sound and vision.

Factors of the soundscape that the participants disliked in the goal condition included technical problems, an inadequate level of clarity and too high a level of challenge. ‘General negative comments’ were only made concerning the non-goal condition. With regards to the non-goal soundscape, participants disliked the lack of variation within the soundscape and the absence of a goal.

In order to make the goal version of the soundscape more compelling the participants would improve the level of clarity, reduce the technical problems and add virtual glasses. In both versions they would make the experience more varied. In the non-goal condition, the soundscape would be improved by the addition of more elements to satisfy sensory curiosity and a goal.

Having experienced both soundscapes, 23 out of 24 participants stated that they preferred the goal version to the non-goal version of the soundscape. One participant preferred the non-goal version because the goal version lacked clarity. The most common reason for preferring the goal version was that it contained a goal. Other reasons included the amount of variation and the level of challenge.

Thus, the results appear to be consistent with the experimental hypothesis that intrinsic motivation is higher when an experience has a goal.

5.2 What do the Findings Mean?

The majority of the participants preferred the goal condition to the non-goal condition. Also, they stated that they liked the goal in the goal version and would make the non-goal version more compelling by adding a goal. Perhaps the most obvious explanation for these findings is that presence of a goal does effect motivation. However, perhaps there is another explanation. Participants stated that they liked the nature of the technology used in the goal condition, but not in the non-goal condition. Therefore, it is possible that the goal condition was preferred because the technology used was perceived to be more compelling. The technology may have been more compelling in the goal condition to the participants because it was used in a slightly different way to in the non-goal condition. In the goal condition, some of the aura within the soundscape had conditions on them using a token system, meaning that they could have different behaviours attached to them and the behaviour activated depended on the user's history. In the non-goal condition, no conditions were placed on the auras. Thus, the technology would not have been as interactive in the non-goal condition and therefore, this may have been why it was less interesting to the participants.

However, when asked which elements of the non-goal soundscape they disliked the participants did not refer to the technology and its interactive nature. Also, the elements that they suggested needed modifying to render this soundscape more compelling did not include the nature of the technology, they were the addition of a goal and more sounds. Thus, it can be assumed that the difference in the technology had a minor effect on the dependent variables, whereas, goal was the main influencing factor.

Further work could attempt to replicate the current findings, controlling as much as possible for differences in the technology used.

A second possible explanation for our findings was that there was less to do (that is, less sounds to listen to) in the non-goal version than in the goal version. But, was this actually the case? The average number of levels completed in the goal condition was 0.75 out of a possible 3 levels. Thus, participants were on average only experiencing less than a third of the game. This means that the difference between the quantity of sounds in the two conditions was negligible. Had the participants completed the three levels then there would indeed have been more variation of sounds in the goal condition, but in only trying level one, the amount of sound in the soundscape was almost identical. Consequently, it seems justified to reject this explanation for the differences across conditions.

A final possible confounding variable was the lack of clarity, which was only identified in the goal version. This was the reason given by the lone participant for preferring the non-goal version. That is, the participant did not understand what the aim of the goal version was because the instructions were not clear enough. Thus, it seems that in this case, the lack of clarity in the goal condition effected the dependant variable – preference. As this was only one instance in 24 it is possible to ignore this. However, it would be interesting in future to repeat this research controlling as much as possible for clarity.

On balance, it seems that the most likely explanation for the findings is that a causal relationship does exist between goal and interest (as measured by preference, interest in soundscape and in fantasy, and wanting to repeat the experience) and between this goal and working collaboratively.

5.3 Further Work

As previously mentioned, it would be interesting to replicate this study, controlling confounding variables as much as possible, to see if the same result occurs. It would also be interesting to collect video data with sound. There would have to be more

than one video camera and each participant would have to have a microphone recording what was said. This audiovisual data could be analysed looking at for example, social interaction (such as number of times participants communicate with one another or copy one another) and strong display of emotion, both positive and negative. This could give further insight into what makes an experience good or bad.

A second area of further work would be to investigate other area of Malone & Lepper's theory of intrinsic motivation. The experiment could be extended to include other elements of Malone & Lepper's (1987) model to test whether they have an effect on motivation or to see if there are interactions between individual elements of the model. For example, some elements may have a negative effect on one another, an obvious example is competition and co-operation. Investigating such interaction could lead to the production of more usable heuristics/ general design principles.

A third area of further work would be to extend the study to include adult participants. As was reported earlier the adults in the pilot study interacted very differently with the soundscape than the children. Perhaps, this is due to the adults being able to cope better with the high level of challenge (although they also seemed to find it too hard) or perhaps there are general differences between what children find motivating and what adults find motivating. Another possible difference could be that for the adults this was their workplace whereas for the children the whole experience was completely new to them.

This leads us to the fourth area where the study could be extended. It could be implemented away from the artificial confines of Hewlett Packard and onto the streets. In fact, Hewlett Packard are planning to implement this technology outdoors next to Explore@Bristol. Thus, it would be possible to compare children's and adults' reactions in a more natural environment.

5.4 Implications

Our findings have qualified Malone & Lepper's (1987) theory that presence of an appropriate goal increases motivation. Thus, Malone & Lepper's (1987) framework has implications regarding the design of compelling experiences. The table below outlines how this framework could have been used to design the soundscape.

Table 8: Implementing Malone & Lepper's (1987) Design Heuristics in the Redesign of our Soundscape

Malone & Lepper's (1987) Design Heuristic		Implication for our Soundscape
Challenge	Present clear goals / allow user to generate own goals.	Make sure the instructions clearer
	Uncertain outcomes:	
	<ul style="list-style-type: none"> ▫ Variable difficulty level 	<ul style="list-style-type: none"> ▫ Already present (the level they are on is determined by their skill), but could also allow users to choose which level they start at 'Easy, Moderate, Difficult'
	<ul style="list-style-type: none"> ▫ Multiple level of goal 	<ul style="list-style-type: none"> ▫ Provide goals that have multiple levels. There could be more than one crystal which could be in different places which vary in level of difficulty
	<ul style="list-style-type: none"> ▫ Hidden information 	<ul style="list-style-type: none"> ▫ Already present: The user find the hidden stepping stones.
	<ul style="list-style-type: none"> ▫ Randomness 	<ul style="list-style-type: none"> ▫ Addition of bonuses that are given at random. For example, could make the player capable of walking across the water to the island.
	Performance feedback (frequent, clear, constructive and encouraging).	Make the feedback clearer and more constructive so user instantly understands what it means. Make the feedback frequent enough that the user does not get left wondering what they should be doing.
	Personally meaningful goals with fantasy or social relevance to user.	Provide a choice of fantasy, by having area divided into different themes, thus increasing the chance that the user will find a fantasy of personal interest to them.

Malone & Lepper's (1987) Design Heuristic	Implication for our Soundscape	
Curiosity	<p>Sensory curiosity may be enhanced by:</p> <ul style="list-style-type: none"> ▫ Varying visual and audio effects ▫ Promoting interactive exchange between the system and the user. 	<ul style="list-style-type: none"> ▫ The use virtual reality goggles to add some more visual effects and more audio effects ▫ Making the system more interactive And the use of more secret places in the soundscape which could only be accessed with certain tokens
	<p>Cognitive curiosity may be promoted by:</p> <ul style="list-style-type: none"> ▫ causing the learner to be surprised and intrigued by paradoxes or incompleteness. 	Applicable to educational applications
Control	<p>To provide feelings of self-determination:</p> <ul style="list-style-type: none"> ▫ a responsive environment ▫ activity should provide moderately high levels of choice ▫ activity should permit the user to produce powerful effects. 	<ul style="list-style-type: none"> ▫ The outcomes of the soundscape were dependent on users' behaviour. ▫ An optimal level of choice exists. So could offer a few different 'environments' and choice within each environment. ▫ These powerful effects could be audio or visual.

Malone & Lepper's (1987) Design Heuristic		Implication for our Soundscape
Fantasy	Emotional aspects: Fantasies should encourage identification with imagined characters or contexts.	The soundscape could present several fantasies and several characters aimed at the target audience, be it adults or children.
	Endogeneity: Fantasy should have an integral relationship to the material to be learned.	Only relevant to an educational application.
Co-operation	Endogenous co-operation may be enhanced by splitting the activity into inherently independent parts.	There could be more than one sub-goal. Thus, keys must be found, as well as poison to put a nasty dragon to sleep. One person must find the keys, another must find the poison and they can only complete the mission if they have both.
Competition	Endogenous competition may be produced by creating an activity in which competitors' actions affect one another.	Change the game so that everyone is searching for the same key and once someone has found it the level changes and everyone is looking for the second key.
Recognition	Endogenous recognition may be produced by activities providing natural channels for their efforts to be appreciated by others.	When an individual gets a key and the game changes level. It could be made known to other participants who brought the key. For example, the fairy could say "Thanks very much John. Hey everyone! John got me a key. Find the stepping stones to the second key."

6. Conclusion

This study has investigated a difference between two theories of motivation, that of Kidd (2001) and that of Lepper & Malone (1987). Contrary to Kidd (2001), Lepper & Malone (1987) claim that goal is an important motivating factor. In our experiment it was found that presence of goal did have an effect on motivation. The implications of this study are that Malone & Lepper's (1987) theory of intrinsic motivation provides a good theory for the design of soundscapes.

7. References

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Appendix 1: Heuristics for Designing Intrinsically Motivating Instructional Environments (Malone & Lepper 1987, p248)

Component of Theory of Intrinsic Motivation		Heuristic
INDIVIDUAL MOTIVATIONS	Challenge	<p>The activity should provide a continuously optimal (intermediate) level of difficulty for the user</p> <ol style="list-style-type: none"> 1. Goals--The activity should either (a) present clear, fixed goals or (b) provide an environment in which it is easy for students to generate goals for themselves at an appropriate level of difficulty. The activity should provide both short-term and long-term goals. 2. Uncertain outcomes—Uncertainty of outcome may be produced using: <ol style="list-style-type: none"> a) Variable difficulty levels b) Multiple levels of goal c) Hidden information, selectively revealed d) Randomness 3. Performance feedback—Performance feedback should be frequent, clear, constructive, and encouraging. 4. Self-esteem—The activity should employ graded difficulty levels and positive feedback techniques to promote feelings of competence. The activity should employ personally meaningful goals that have instrumental, fantasy, or social relevance for the user.
	Curiosity	<p>The activity should provide an optimal (moderate) level of informational complexity or discrepancy from the user's current state of knowledge and information.</p> <ol style="list-style-type: none"> 1. Sensory curiosity—Sensory curiosity may be enhanced by variability in audio and visual effects. The activity should promote interactive exchange with the user. 2. Cognitive curiosity—Curiosity may be promoted by instructional techniques that cause users to be surprised and intrigued by paradoxes, incompleteness, or potential simplifications. Cognitive curiosity will be enhanced when activities deal with topics in which the user is already interested.

	Control	<p>The activity should promote feelings of self-determination and control on the part of the user.</p> <ol style="list-style-type: none"> 1. Contingency—The activity should provide a responsive learning environment. 2. Choice—The activity should provide and emphasise moderately high levels of choice over various aspects of the learning environment. Personalisation of the activity may enhance perceptions of choice. 3. Power—The activity should permit the user to produce powerful effects.
	Fantasy	<p>The activity may promote intrinsic motivation through the use of fantasy involvement.</p> <ol style="list-style-type: none"> 1. Emotional aspects—Fantasies should be designed to appeal to the emotional needs of users. Fantasies should encourage identification with imagined characters or contexts. 2. Cognitive aspects—Fantasies should provide appropriate metaphors or analogies for the material presented for learning. 3. Endogeneity—Fantasies should have an integral, endogenous, relationship to the material to be learned.
INTERPERSONAL MOTIVATIONS	Co-operation	<p>The appeal of the activity may be enhanced by enlisting the motivation to co-operate with others. Endogenous co-operative motivation may be produced by segmenting the activity into inherently independent parts.</p>
	Competition	<p>The appeal of the activity may be enhanced by enlisting the motivation to compete with others. Endogenous competitive motivation may be produced by creating an activity in which competitors' actions affect each other.</p>
	Recognition	<p>The appeal of the activity may be increased if the user's efforts receive social recognition. Endogenous recognition motivation may be produced by activities that provide natural channels for students' efforts to be appreciated by others.</p>

Appendix 2: Agenda for participants of the experiment, 9th July 2002

Time	Group 1	Group 2	Group 3
11:00	EXPERIMENT	TOUR	TALK
11:30	EXPERIMENT	TALK	TOUR
12:00	TALK	EXPERIMENT	LUNCH
12:30	LUNCH	EXPERIMENT	LUNCH ACTIVITY
1:00	LUNCH ACTIVITY	LUNCH	EXPERIMENT
1:30	TOUR	LUNCH ACTIVITY	EXPERIMENT

Appendix 3: Instructions to participants

General introduction

We are interested in making soundscapes. Using a soundscape involves wearing a personal portable computer and walking around a physical space. As you move around the space you hear different sounds depending on where you are.

We have developed two SoundScapes. We would like you to try each soundscape and answer a questionnaire on it. We must stress that the questionnaire is not a test it is to get your opinions.

If at any stage you decide you no longer wish to take part in this experiment then you do not have to. Let us (Jessica, Jo or Richard) know if you decide not to take part.

Condition 1 (soundscape 1 i.e. with goal)

a) Experiment

You have 10 minutes to explore this first soundscape. You must start at the transistor radio.

b) Evaluation

We would like you to answer this questionnaire about the soundscape you have just experienced. Please remember this is not a test and we are interested in your opinions.

Condition 2 (soundscape 2 i.e. without goal)

a) Experiment

You have 10 minutes to explore this second soundscape. You must start at the transistor radio.

b) Evaluation

We would like you to answer this questionnaire about the soundscape you have just experienced. Please remember this is not a test and we are interested in your opinions.

Appendix 4: Coding Categories for Open-ended Questions

Code Category

1. Goal
 2. Level of challenge
 3. Amount of variation
 4. Level of clarity (i.e. suitability of the instructions or of the feedback)
 5. Freedom of participant
 6. Fantasy
 7. Competition
 8. Collaboration
 9. Recognition
 10. Cognitive curiosity about the Technology
 11. Sensory curiosity – Sounds, vision, etc.
 12. Technological problems
 13. General positive comment e.g. ‘interesting’
 14. General negative comment e.g. ‘boring’
 15. Other
-

<u>Appendix 5: Coded Answers to Open-Ended Questions in the Condition Specific Questionnaires</u>									
				Question 13: Why did you like the soundscape?		Question 14: Why did you dislike the soundscape?		Question 15: How could the soundscape be more compelling?	
Participant	Gr.	Sex	Order	Goal condition	Non-goal condition	Goal condition	Non-goal condition	Goal condition	Non-goal condition
P1	1a	F	g then ng	"voice were very funny and liked the story" 6, 11	"the music and the sounds in the seas" 11	"fairy didn't tell me when I found a stone and I couldn't tell what some noises were" 4	"I didn't know what to do.. The speaking wasn't all that clear." 4	"should be more to the game or ..actually..sand there..it could feel more real" 3, 6,11	"Have a bigger landscape with more sounds because after a while it was boring having explored everywhere." 3, 14, 11

P2	1a	M	g then ng	"enjoyed the plot...and ...laid-back approach." 15	"the animal noises and walking around" 11, 5	"instructions were very unclear...needed to stay very still to pick up signals." 4, 12	"boring after a while because you had heard all the noises. " radio kept restarting 14, 12	"larger environment ...Signals further expanded so could be recognised from further away. Make more interactive, exciting and modern" 3, 12	"if there was something else to do + if the radio, fairy + things on the island said different things... and if there was ...completing tasks." 3, 1
P3	1a	F	g then ng	stepping stones 6	"you were free to do what you want when you want with little restrictions." 5	not enough feedback, confusing, especially alarm. 4	"There wasn't much point in it and after you heard everything there wasn't much to do." 1, 3	look for something other than keys, fairy dust wash off quicker, more places to look 3	"more things to listen to..to do, a plot..randomised sounds..ie. More than one thing transistor radio could say." 1, 3, 11
P4	1a	M	g then ng	"radio gave you feedback on where you were in the map. It was very clever." 10	"I loved the pipe music" and modified animal noises. 11	sound flickers and don't hear what others hear in same place 12	"not much of a plot or reason why we were there and exploring" 1, 15	larger environment, more interactive features, more instructions 3, 4, 10	"using an interesting plot to try to make people think rather than listening...more noises and phrases." 1, 10, 11

P5	1a	M	g then ng	"a nice experience" 13	"different music in different places" 10, 11	"confusing" 4	"it was boring" 14	15	"You could have a challenge (or something like that) to do" 1
P6	1b	M	g then ng	"Interesting and new...like real life." 13, 10	"I liked the do-bee-doo music and the animal sounds." 11	"It was quite hard to understand." 4	"There wasn't much to do." 3	"It could be easier to understand and you could have virtual glasses." 4, 15	"There could be more of a plot." 15
P7	1b	M	g then ng	"Lots of sounds...sounded like it came from other places. Interactive." 10, 11	"I liked the doby do music, the water and the cow and the pig." 11	"More instructions" 4	"Not much to do." 3	"More. Virtual glasses. Change what you had to do." 3, 15, 14	"Have a target." 1
P8	1b	F	g then ng	"I liked the sounds because they helped you...." 11	"The sounds in certain places." 11	Nothing 15	"Not much to do." 3	"You could wear glasses that...see a visual side of the sounds." 15	"more sounds / game" 1, 11
P9	1b	F	g then ng	"different sounds...it kept you guessing...it was interesting." 13, 11	"I liked the whales and the funny music the best." 11	"you couldn't see where you were." 4	"That after a while there wasn't a lot to do." 3	"there could be glasses to see where you were." 15	"More sounds and things to do." 3, 11

P10	1b	M	g then ng	"That the people could see what you were doing!" 9	"I liked the beach music!" 11	"The tape kept sticking to my foot." 15	"It was a bit repetitive." 3	"If you could put on virtual glasses and see where you were going." 15	"It could have more things to do." 3
P11	2a	M	g then ng	"I thought it was quite fun and interesting." 13	"The sounds were good." 11	"The voice kept on stopping." 12	"it was a bit boring." 14	"It could have a visual goggle and more realistic situation." 6, 15	"There could be a task." 1
P12	2a	M	g then ng	"The sounds were quite realistic." 11	"It was interesting." 13	"If you stepped out of the area of the computer talking and went back in it would reset." 12	"it was unreal." 6	"It could be more precise in the instructions." 4	"There could be an aim." 1
P13	2a	M	g then ng	"I liked the soundscape because it was fun and quite intersting. The sounds were quite realistic." 11, 13	"The sounds were good." 11	"the voice kept on stopping and it wasn't that clear." 12	"it was hard to understand what to do." 4	"visual goggles and more believable situations." 6, 15	"There could be a task to complete." 1

P14	2a	M	g then ng	"It was interesting the way it was put together and how you had to stand in certain places to get to others." 10	"The funny music" 11	"I didn't like other people doing it at the same time" 9	"Everything apart from Fifi the fairy." 15	"There should be a more exciting story." 15	"It should have a story." 15+K24
P15	2a	M	g then ng	"It was interesting how it was made and the design." 10	"The sounds of all the different people." 11	"I disliked the fairy tale." 6	"What you were supposed to do." 14	"Make the story better." 6	"Make it a bit more interesting." 13
P16	2a	M	g then ng	"It used interesting technology and was different to other games." 10	"Some of the sounds were funny/interesting." 11	"The storyline was a bit boring." 6	"There wasn't much to do / it was boring." 3, 14	"A more interesting storyline and a bigger area to move around in." 3, 6	"By having more things to do and more interesting sounds." 3, 11
P17	3a	M	ng then g	"that it was different to the first." 15	"They had different things to listen to." 3	"Nothing." 15	"nothing" 15	15	"Put even more sounds there." 11
P18	3a	M	ng then g	"There was a task." 1	"They had many things to listen to." 11	"It cut out when I was about to get the third key to the radio." 12	"nothing" 15	"It shouldn't cut out when you walk past." 12	"put more sounds in it." 11

P19	3a	F	ng then g	"there were all different voices." 11	"listening to the sound, hearing what was in the background...wandering with eyes closed and guessing where I was." 11	"It was a bit confusing when we were told to go West and then said I was West." 4, 12	"It was a bit small and the bag was too big to fit around my waist." 3, 15	"If it was easier to cross the sea." 2	"It would be better if there were chairs to sit on and listen to the sounds or more visual items." 11, 15
P20	3a	F	ng then g	"it was interesting...very effective." 13	"it was interesting...you walk around and it would suddenly change. The best was Fifi the fairy." 13, 6	"confusing...you were told instructions and when you did them you lost." 4	"I thought everything was quite good and interesting." 13	"by being clearer." 4	"have more varieties of sounds so you could walk around a few times and not get bored." 11
P21	3b	M	ng then g	"the challenge" 1	"you had to work out what was making the sounds." 2	"I got confused and it stalled a couple of times." 4, 12	"there could have been more sounds." 11	"It needs to be clearer." 4	"there could have been more sounds." 11
P22	3b	M	ng then g	"It was more of a challenge and more interesting." 1, 13	"I liked the different types of beings that spoke and their accent." 6, 11	"It was very hard and you couldn't hear the sounds properly." 2, 12	"it sometimes cut out and restarted suddenly." 12	"if it worked properly." 12	"Different sounds in different places or more to listen to." 11

P23	3b	M	ng then g	"I liked the idea of the mission." 1	"I liked the funny voices telling you where to go at the far end, past the water." 6, 11	"the hardness of it." 2	"I disliked the radio, it sounded a bit out of place in a rain forrest." 6	"make it easier." 2	"There could be more animals." 11
P24	3b	M	ng then g	"It was more of a challenge and more fun." 1, 13	" I really like it, but sometimes it was amazing. I liked it when you talked to the plant." 13	"you could not hear properly all the time and it was hard." 2, 12	"Sometimes you wanted to listen to something and you would listen to something else." 5	"if it worked properly." 12	15
				Note: For explanation of codes please refer to Appendix 4: Coding Categories					

Appendix 6: Coded Answers to Comparative

Question: Why did you prefer the soundscape stated?

Participant	Group	Sex	Condition Preferred	Reason Preferred
P1	1a	M	goal	"Because you had to do something." 1
P2	1a	F	goal	"We had something to do in the first one; like a mission (even though it was hard to understand); but the second wasn't as exciting." 1
P3	1a	M	goal	"A plot and different noises...The pipe music should be transferred to the first." 1, 5
P4	1a	F	goal	"because there was a lot more to do and a point in doing things." 3, 1
P5	1a	M	goal	"It was bigger, better and had more of a plot than the second." 15
P6	1b	M	goal	"There was more to do." 3
P7	1b	M	goal	"It had a target." 1
P8	1b	F	goal	"Because there was more to do." 3
P9	1b	F	goal	"Because there was more to do." 3
P10	1b	M	goal	"It had more to do!" 3
P11	2a	M	goal	"It was more exciting." 13
P12	2a	M	goal	"more interesting." 13
P13	2a	M	goal	"It was more interesting." 13
P14	2a	M	goal	"It was a lot better because you could actually do something." 1
P15	2a	M	goal	"because there was a task in it." 1
P16	2a	M	goal	"It had a story and you had to try to win." 1, 15+F29
P17	3a	M	goal	"it was more of a challenge." 2

P18	3a	M	goal	"There was a task." 1
P19	3a	F	goal	"I liked the second one because it was more challenging. Even though the first one was relaxing." 2
P20	3a	F	goal	"Because it was more challenging. But the first one was fun too..." 2
P21	3b	M	non goal	"because the second was confusing." 4
P22	3b	M	goal	"It was more fun." 13
P23	3b	M	goal	"Because there was more to do." 3
P24	3b	M	goal	"It was more fun." 13

Note: For explanation of codes please refer to Appendix 4: Coding Categories