

國立臺灣大學工學院土木工程學系

碩士論文

National Taiwan University

Master Thesis



環境教育應用：數位繪本的配樂如何引發情感連結

Emotional Induction Effects of Soundtracks in the
Educational Multimedia: A Case Study from Environmental
Education

張沅真

Yun-Chen Chang

指導教授：康仕仲 教授

共同指導：曾敬梅 助理教授

Advisor: Prof. Shih-Chung Kang

Co-advisor: Prof. Ching-Mei Tseng

中華民國 107 年 2 月

Feb. 2018



中文摘要



透過情緒的觸發能增進個體對環境議題的認知與行為改變；因此，如何提升人與自然之間的情感連結是環境教育的重要課題。多媒體教材，例如：影片、遊戲與數位故事…等被認為是能夠有效引發情感連結的教學媒介，近年來也被應用在環境教育的領域。研究顯示配樂很可能是多媒體教材中引發情感反應的強力因素之一，然而，這些配樂普遍未經專業譜曲或設計，因此也未能有效與影像結合並增強觀看者的情緒反應，達致教育目標。本研究延續同一研究團隊的系統性與縱貫性研究，以水環境教育教學影片《水寶》為素材，並依據歸納出的作曲理論為其專門設計配樂，並研究配樂如何配合教學媒材引發情緒反應。本研究的目標是比較「設計配樂」與「現成配樂」所引發之情緒反應是否符合預期與假設。36 位大學生經過第一階的篩選，根據其對音樂的感受與環境的感受被分配成背景均等的兩組，其中一組觀看配有設計配樂的《水寶》，另一組則觀看使用現成音樂作為配樂的《水寶》。觀看過程中，受測者必須以研究者所特別設計的紀錄工具同步紀錄其情緒反應（正向、負向，或其他），情緒資料則使用視覺化工具進行紀錄、轉化與分析。看完影片後，受測者被邀請立即進行關於影片觀看過程情緒感受的追蹤訪談。研究結果顯示配有設計配樂的《水寶》能引發觀看者較精準（亦即符合設計）的情緒反應，現成音樂則容易使觀看者對影片產生與設計意圖不符之解讀。從訪談中，受測者指出現今教育媒材的配樂確實需要改進，並提出影片長度、旁白字詞與情緒的多寡、影片知識的難度、劇情的可預測性，以及影片的教學場合皆是影響配樂設計準則的因素。

關鍵字：配樂、教育多媒體、情緒反應、數位故事、環境教育

Abstract

Inducting learners' emotional connection with nature is crucial in environmental education. Educational multimedia, like videos and games, have been recognized and gradually applied to influence students' emotions, awareness, attitude and behavioral changes. Soundtracks, an effective emotion stimulus, however, has rarely been professionally dealt with or integrated to enhance educational multimedia. The present study fills a void by linking the emotional induce effects with composed soundtracks and continues to explore the affective aspects of educational multimedia. In the present study, soundtracks were composed by the researcher to integrate with *WaterBob*, a digital storybook created by the same research team. The purpose of the present research is to investigate effects of soundtracks (composed or compiled canned soundtracks) and emotional induction on environmentally responsible behavioral intentions. The sample consisted of 36 college students. Participants were randomly assigned into two groups. While watching the videos, one group listened to composed soundtracks, whereas another group listened to compiled soundtracks downloaded from online musical service platform. Participants were simultaneously asked to provide emotional reactions (positive, negative, or mixture). A visualization tool was developed to document and further analyze the data. The result indicated a significant difference in emotional induction between the two groups. The follow-up interview showed a significant relation between emotional induce and environmentally responsible behavioral intentions. In addition, the duration, the complexity of the content, the narration, the predictability of the plot, and the educational occasion are considered important factors for soundtrack design, and were further discussed.

Keywords: soundtrack, educational multimedia, emotional induce, digital story, environmental education

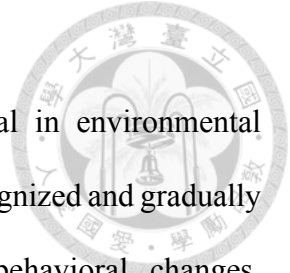


TABLE OF CONTENTS



中文摘要.....	i
ABSTRACT.....	ii
TABLE OF CONTENTS.....	iii
LIST OF FIGURES.....	v
LIST OF TABLES.....	vi
Chapter 1. Introduction.....	1
1.1 Background.....	1
1.2 Research Goal.....	3
1.3 Research Questions.....	3
1.4 Definitions of Terms.....	4
Chapter 2. Literature Review.....	5
2.1 Educational multimedia in environmental education.....	5
2.2 The Functions of Soundtracks in the Context of Multimedia.....	9
2.3 The Difference between Composed and Compiled Soundtracks.....	11
2.4 Summary.....	13
Chapter 3. Soundtrack Design.....	14
3.1 Soundtrack Elements Inducing Emotion.....	14
3.2 The Audio-Visual Counterpoint.....	15
3.3 Leitmotiv.....	17
3.4 The Analysis of Mode.....	17
3.5 Practices of Soundtrack Design.....	20
3.6 Soundtrack Design of <i>WaterBob</i>	21

Chapter 4. Methodology.....	28
4.1 The Educational Multimedia – WaterBob.....	28
4.2 Participants.....	30
4.3 Data Collection.....	32
4.4 Experiment Design and Data Analysis.....	34
4.5 Procedure.....	34
Chapter 5. Results and Discussion.....	37
5.1 The Heat Map of Emotional Induction.....	37
5.2 Soundtrack Design Issues and Principles.....	44
Chapter 6. Conclusion.....	47
Reference.....	49
Appendix 1. Full Content of <i>WaterBob</i>	52
Appendix 2. Sheet of <i>WaterBob</i>	79



LIST OF FIGURES



Figure 1 The audio-visual counterpoint.....	16
Figure 2 The audio-visual counterpoint of <i>WaterBob</i>	22
Figure 3 WaterBob and the leitmotiv.....	23
Figure 4 The Mouse and the leitmotiv.....	24
Figure 5 The Cat and the leitmotiv.....	25
Figure 6 The Rabbit and the leitmotiv.....	26
Figure 7 The emotion categories of <i>WaterBob</i>	33
Figure 8 The documenting tool.....	33
Figure 9 The heat map of emotional induction.....	38
Figure 10 The emotional flow.....	39
Figure 11 The unexpected emotion responses.....	40

LIST OF TABLES

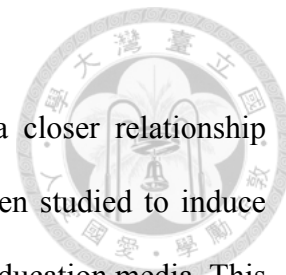


Table 1 The designed rubric of soundtrack (adapted from the research of digital storytelling by Barrett (2006))	7
Table 2 The function of composed and compiled soundtracks.....	11
Table 3 Sections of <i>WaterBob</i>	21
Table 4 The design of leitmotiv of WaterBob.....	23
Table 5 The design of leitmotiv of the Mouse.....	24
Table 6 The design of leitmotiv of the Cat.....	25
Table 7 The design of leitmotiv of the Rabbit.....	26
Table 8 The design of leitmotiv of the main theme.....	27
Table 9 The emotion expression of <i>WaterBob</i>	29
Table 10 Grouping Result.....	31
Table 11 The count and percentage of unexpected emotion (t-test).....	42
Table 12 Elements of soundtrack design.....	46





Chapter 1. Introduction

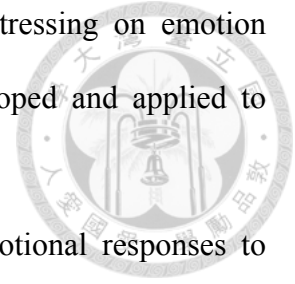


Environmental educational have been facing difficulties. For a closer relationship between human and nature, effective education strategies thus have been studied to induce emotion. Among all the strategies, our research team focused on digital education media. This research focused on how soundtracks, the audio aspect of the media, induce viewers' emotion and enhance the transfer of education. Composing theories were applied to a digital storybook, *WaterBob*, to examine the effect of the soundtracks was examined and to study important factors for soundtrack design.

1.1 Background

The rise of human awareness as well as the acquisition of knowledge of the concept of environmental education, e.g., water conservation, are considered a civic responsibility (Slattery & Rapp, 2003). The government and industry have sought to promote water resource conservation activities, and students and the general populace are expected to learn about water conservation. However, environmental education nowadays is facing difficulties to some extent; i.e. the fragile relationship between nature and industrialized society makes it hard for educators to raise public environmental awareness. One's environmental awareness and attitude have a personal and social component, and exist within all individuals who care about the environment that leads to pro-environmental behaviors. Among various of studies strive to solve the above problem, more and more recent studies have been investigating factors that help establish a closer relationship between human and nature. Their research has shown that affective factors such as *emotion*, *meaning*, and *affection* are critical to nature connectedness (Berenguer, 2007; Lumber et al., 2017). Specifically, emotional connection with nature is considered beneficial to pro-environmental behaviors. One of the effective and meaningful method is to *educate* people via both formal and informal learning activities with a focus on

emotional connection. As a result, teaching methods and materials stressing on emotion induction have not only been received more attention but also developed and applied to environmental education practice.



There is still a significant void in the literature regarding emotional responses to information, awareness and intentional behaviors about the environmental issues. Although previous research has considered the importance of affection aspects in environmental education, the role of emotional induce has been overlooked (Perrin, 2011). It seems appropriate to begin to explore the influence of emotional induce of individuals' behavioral intentions and curiosity regarding environmental information, particularly via educational multimedia.

In the past decades, affection education strategies thus have been developed to raise individual's awareness in the field of environmental education, including field trips (Farmer et al., 2007), digital game (Cheng et al., 2013), and videos (Hill and Nelson, 2011). In addition to knowledge-, lecture-based learning, the above alternative and informal ways of learning have shown positive effects on the connection between the human-nature relationship. Among these strategies, our research team has focused on the development and validation of a series of educational multimedia, including computer games (Kuo, 2013), virtual reality (VR) games (Hsu, 2017), and digital storybook (Yang, 2017). These educational multimedia was developed in hope of increasing learners' awareness and the behavior intention of water conservation. Empirical study studies were conducted to examine the effects of each experimental intervention. Most consistently, the results showed significant changes in cognition and behavior intention.

1.2 Research Goal

The present study strives to link the emotional induce effects with composed soundtracks and continuing to explore the affective aspects of educational multimedia, specifically, to exam the emotional impact of soundtracks in educational multimedia. The researcher predicted that composed soundtracks would trigger significant differences in expected emotion (positive or negative) that exhibits emotional induction, compared to compiled soundtrack design.

Applying composing theories, the soundtracks were designed and added to a digital storybook, *WaterBob* (Yang, 2017). Yang's study focused on the development and validation of effects of digital stories in the environmental education. The results from her research indicate that digital stories may trigger significant emotional responses. Through the practice of soundtrack design, we expected to achieve the following objectives: (1) to exam whether composing theories could be meaningfully applied in educational soundtracks to induce anticipated emotional responses, (2) to develop more specific soundtrack design rubrics as a reference for future application in the educational field.

1.3 Research Questions

Based on the objectives of our soundtrack design, the following research questions are set:

Q1: Could composed soundtrack of educational multimedia trigger expected emotional reaction?

Q2: Follow upon the first question, what are the essential elements for soundtrack design?

1.4 Definitions of Terms

Educational Multimedia

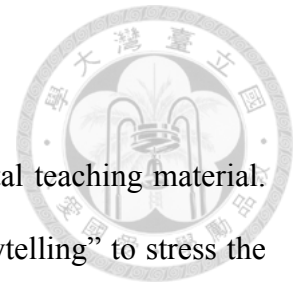
Research in different fields uses different words to refer to digital teaching material. While educational experts (Robin, 2005; Barret, 2006) use “digital storytelling” to stress the importance of story, musicologists (Bullerjahn, C. and Güldenring, M., 1994; Cohen, 2001; Boltz, 2004) use various words including multimedia, film, video, clip, and audiobook according to the characteristic of the experiment design and materials. In this paper, the researcher uses the term “educational multimedia” since it could represent most of the words used in musicology, and could as well stress the educational context.

Soundtrack and Music

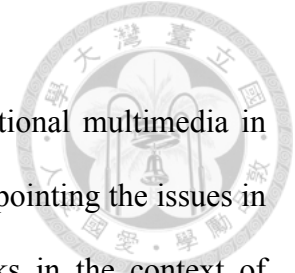
Both soundtrack and music is used to indicate audio materials in this paper. Whereas “soundtrack” refers to practical use and the entity of the audio material, “music” refers to theoretical implication. In addition, the word “music” are used in this paper while the connection between audio and visual is not the primary concern.

Composed and Compiled

In the following chapter 2 types of soundtracks would be discussed: the composed and the compiled. The former refers to soundtracks explicitly composed for specific multimedia, while the latter refers to music with other design purpose but is used as a second-hand or canned soundtrack in multimedia.



Chapter 2. Literature Review



In this chapter, the researcher first introduces various of educational multimedia in environmental education, with a focus on emotional induction. After pinpointing the issues in soundtrack design of educational multimedia, functions of soundtracks in the context of educational multimedia were discussed, such as how does soundtrack as revenue to induce emotion that better interpret digital stories. Following a discussion of needs and problems of composed soundtracks, instead of compiled ones.

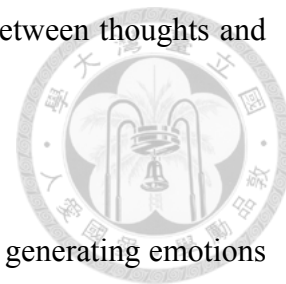
2.1 Educational multimedia in environmental education

In recent years, schools and the academics have been emphasizing on multimedia technology. Films, videos, and short clips are used as teaching materials in and out of the classroom for environmental education. These multimedia are considered beneficial for both the teachers and the students in a variety of aspects. Most of these materials are knowledge-based instructions (Hill and Nelson, 2011); however, emotive videos have also been proved to be even more useful (Dorian and Litchfield, 2011). As researchers begin to explore human's emotional connection to nature, it is important to investigate their self-awareness and behavioral implications of this connection by the revenue of educational multimedia (Perrin, 2011). That is, emotion induction is important in environmental education. Digital storytelling, an emotive instruct method (Robin, 2005), thus could be served as an effective strategy in environmental education nowadays.

The role of emotion in educational media

Emotion is a core component of human experiences, which also may lead to changes in decision-making, memory and behaviors. Among various research approaches, most of the researchers agree upon that all emotional consist of feeling states involving positive or negative valence (Schutz et al., 2006). Emotions can assist in the way information is received, retained,

interpreted, and used (Perrin, 2011). There is a reciprocal relationship between thoughts and emotions.



Elements of educational multimedia that induce emotion

Emotions are necessary for learning purpose. Learning materials generating emotions can be applied to transfer knowledge (Hinton et al., 2008). One of the material, educational story videos, was termed as “digital storytelling”.

According to Center of Digital Storytelling (2005), there are seven elements of a multimedia: perspective, a critical question, emotional content, audio narration, supportive soundtracks, economy, and pacing. These elements could further be categorized into four aspects: story (elements 1~4), audio narration (element 4), music (elements 5), and production (elements 6~7). Among these aspects, story and music have been used to induce emotion. Storybooks have been used to instruct environmental issues. Yang (2017) also demonstrates how people connect to natural objects through an object view story in digital story form. Music, on the other hand, has also been proved to be an effective emotion stimulus no matter in or out of the context of visual presentation (Kreutz et al., 2008; Cohen, 2001). However, while most of the multimedia in environmental education are with carefully designed plots that full of originality, the music aspect has rarely been professionally dealt with. Often, free-download music was used and could not support the story to induce emotion.

Issues in soundtrack design of educational multimedia

According to Robin (2005), a well-composed soundtrack for educational multimedia should be original and could induce emotion responses (Table 1). This rubric, the only literature mentioning soundtrack design in educational multimedia, provided an overall design principle that seemed apparent. However, the researcher of this paper indicates 2 critical fallacies hidden in the rubric.

The first fallacy is that a soundtrack should be judged within the context of the story. Music that induces rich emotional responses does not necessarily trigger the same reaction when put in the visual context; on the other hand, music that is not evident could sometimes induce rich emotion if combined with appropriate visual components. A piece of soundtrack could only be useful when integrated with suitable film (Lipscomb and Kendall, 1994; Boltz et al., 1991). Viewers are not going to feel happy hearing something in major Key if the visual scene is horrible. A good example would be the movie *A Clockwork Orange*. The lead character, Alex, is a big fan of Beethoven and also a cruel scoundrel. When Beethoven's symphony No.9, a passionate piece of music, was combined with horrible montage scenes in the movie, the audience feels horrified instead of excited.

The second fallacy is that the rubric did not consider the application on different multimedia. There are many ways to present storytelling multimedia. Robin (2006) categorized storytelling multimedia into 3 groups: personal narratives, historical documentaries, and stories that instruct a particular concept. Each of the group should have its soundtrack design rubric since the content, story structure, narration, and target emotion all differ from each other.

Index	Excellent	Good	Satisfactory	Needs Improvement
Soundtrack – Emotion	Music stirs a rich emotional response.	Music stirs an emotional response.	Music is evident.	Inappropriate choice of music.
The Power of Soundtrack – Originality	All of the music is original.	Over half of the music is original.	Some, but less than half of the music is original.	None of the music is original.

Table 1 The designed rubric of soundtracks (adapted from the research of digital storytelling by Barrett (2006))

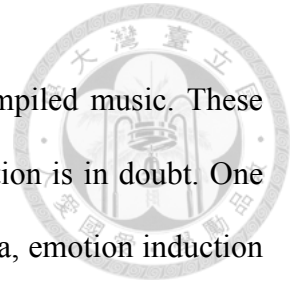
Problems and needs of soundtrack design in educational multimedia

Multimedia in the educational field tends to use free-download or compiled music. These soundtracks are thus lack of originality, and their ability to induce emotion is in doubt. One possible reason might be that for traditional knowledge-based multimedia, emotion induction is not as important, soundtrack design is thus neglected. However, when we now focus more on affection factors in educational materials, music, an effective emotion stimulus, should receive more attention and be seriously dealt with. The lack of a *good* design guideline might be another reason why the soundtracks nowadays are of low quality. With a better rubric, the soundtracks in educational multimedia could be more supportive for the story.

Follow upon a series of studies from a granted longitudinal project of the same research team, the present thesis extends Yang's (2017) research on the development the effect of environmental educational multimedia and further examine the emotional impact by adding soundtrack on top of the digital storybook.

2.2 The Functions of Soundtracks in the Context of Multimedia

Although there has been little research about soundtracks in educational context, musicologists have been studied on people's emotional reaction toward soundtracks in multimedia. According to Cohen (1999, 2001), music is one of the strongest sources of emotional expression in film, and there are 8 functions of music in multimedia. First, music masks unwanted environmental noises; second, music signals connection separation between different shots or events; third, music directs viewer's attention to specific visual aspects or objects, and thus could induce emotion towards the focus objects; fourth, music induces mood; fifth, music communicates meanings; sixth, music serves as a memory "hook"; seventh, music enhances the immersive experience in a film; finally, music provides another aesthetic aspect for film. Six out of the eight functions has been regarded contributive to emotion induction (Cohen, 2001). Many studies have also validated the functions mentioned above.



Although research on this topic usually requires more conditions since researchers need to specify whether emotion reaction is induced by music alone, film alone, music in the context of film, or film in the context of music, experiments have successfully proved that music plays a significant role of emotion stimulus, many validates Cohen's statement. Although there are also many studies about how pure music influences emotion, researchers only focus on music in multimedia context in this paper.

Soundtrack as revenue to induce emotion

As Kalinak (1992, p.92) has strongly claimed, soundtracks are “the most efficient code” that expresses emotion in film. Through pitch, timing, and loudness characteristics in music can induce different emotion that can be incorporated into the visual information (Hevner, 1936; Rigg, 1964; Scherer, 1978). An experiment conducted by Baumgartner et al. (2006) demonstrated the above statements. When fearful and sad pictures either alone or combined with congruent emotional musical excerpts (classical pieces) were presented to the participants, the result clearly showed that music increased the emotional experience of the subjects. Additional emotion processing brain activity was also found when music was combined with visual information.

Soundtracks as revenue for a better understanding of a story

When combined with visual information, music's ability of emotion induction could even influence how the visual information is interpreted. The emotion triggered by music would hook themselves to the visual objects or the implied meaning of the narrative (Cohen, 2001) and could thus control, or bias the interpretation of visual events. In a study conducted by Bullerjahn and Gldenring (1994), a 10-minute film segment was presented to the subjects with one of 5 different soundtracks. The result showed that the soundtrack is indeed a factor influencing viewer's judgements. The difference between the judgements included the appropriateness of emotional categories (sad, thrilling, sentimental, vivid), the genre of the film

(horror, comedy, thriller, crime), the intention for the character's actions, and the expected ending of the film.

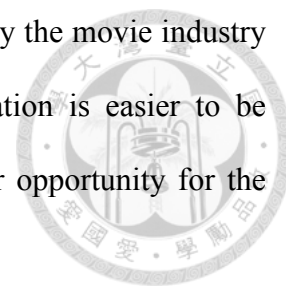
Another experiment was done by Thompson et al. (1994) further demonstrated that specific music rules did influence how the closure of a film was interpreted. In their research, a soundtrack ended with a dominant chord to tonic chord (the closed soundtrack) was proved to significantly increase the judgement of the closure of a film compared to an unclosed soundtrack, which differed only in the final bar.

How soundtracks guide the emotion and interpretation in films is especially important when the meaning of a film is ambiguous. Boltz (2001) asked subjects to watch 3 ambiguous film segments with either positive music, negative music, or no music at all. The result showed that compared to the no-music group, positive and negative music not only bias subjects' interpretations but also their mood-congruent memory of the film. Participants in the experiment showed that music influences their judgement of characters' relationships to one another, the intention of the characters, and even which elements are best-remembered.

Soundtracks as revenue for remembering a story

The fact that music could enhance emotional expression and lead the interpretation of a film makes film information be encoding as an integrated memory and could be remembered better. A study by Boltz (2004) demonstrated that musical soundtracks influence the remembering of film information. In the experiment, subjects viewed a set of music/film clips that were either emotional congruent or incongruent. The participants were then asked to recall the music, the film, or both in tandem. The results showed that the viewers encoded the emotion congruent music as integrated information while incongruent music encodes the film and the music independently. This study provided a possible explanation for why mood-congruent music helps remember film information (Boltz, 1991). When the audio and visual dimension in multimedia are encoded as a whole, it is easier for the viewers to remember rather than

remember the music and film independently. This could also explain why the movie industry pays serious attention to soundtrack production. Since audio information is easier to be podcasting on different media, a hit theme song could provide a better opportunity for the audience to recall information and emotional expression in a film.



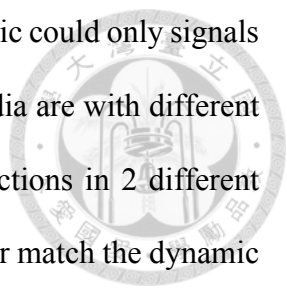
2.3 The Difference between Composed and Compiled Soundtracks

Despite the negligence of soundtrack design in educational multimedia, the value of composed soundtracks should not be underestimated. A study by Lipscomb and Kendall (1994) proved that the professionally designed soundtracks do match the film better. The participants viewed 5 different segments in a feature film, *Star Trek IV: The Voyage Home* and asked them to choose the best fitting soundtrack for each segment. In all the segments, the soundtrack that most frequently selected was the score originally composed for the excerpt. This experiment showed that a soundtrack specifically designed for a film differs from any other music. However, what element in music makes the composed soundtrack unique remains implicit. We may try to analyze the difference based on the 6 functions of music that induce emotion reaction in a film proposed by Cohen (2001).

Function of Soundtracks	Composed	Compiled
1. Provision of Continuity	v	△
2. Direction of Attention	v	△
3. Mood Induction	v	△
4. Communication of Meaning	v	△
5. A Cue of Memory	v	△
6. Immersion	v	△

v: function fulfilled △: function fulfilled incompletely

Table 2 The function of composed and compiled soundtracks

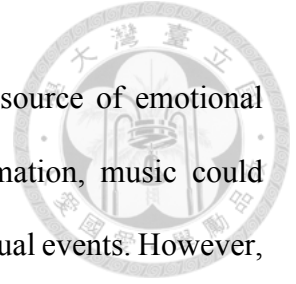


As shown in Table 2, for the provision of continuity, compiled music could only signals separation but not continuity. Since all the canned music in one multimedia are with different orchestration, style, mixing, it is hard for canned music to make connections in 2 different scenes or events. For the guidance of attention, a music excerpt must either match the dynamic aspect or the implied meaning of an object. It is difficult for a piece of compiled music to meet this requirement while at the same time fits the plot and emotion of the visual part. For mood induction, Baumgartner et al. (2006) have proved that emotional congruence is a critical factor for music excerpts to support the emotional expression in a film. For communication of meaning, Bullerjahn and Güldenring (1994), Thompson et al. (1994), Cohen (2001), and Boltz (2001) have shown that emotional congruent soundtracks had the power to lead viewers' interpretation of a film. For memory enforcement, as Boltz (2004) indicated, when the audio and visual dimension in multimedia is integrated, the viewer would remember the film better. For immersion, since music contributes to the reality of the narrative, the more the music fits the film's emotion, plot, historical setting, and pacing, the more the viewer can immerse in a film.

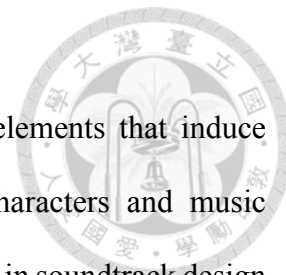
One may argue that for function 3, 4, and 5, emotion congruence plays a critical role on whether a piece of compiled music could function as well as composed music. This is indeed a question need to be further investigated. Although many of the educational multimedia uses emotional incongruent music as backgrounds, there are still some multimedia in which the musical emotion matches the visual information. In what way the emotion congruence compiled music differs from emotion congruence composed music thus become an issue worth investigating.

2.4 Summary

To conclude, the soundtrack serves as a potentially substantial source of emotional expression in multimedia context. When combined with visual information, music could influence the emotional reaction, the interpretation, and the memory of visual events. However, it seems not all soundtracks can achieve these functions. Composed soundtracks have been proved to match film segments better and could be recognized by the viewer. However, what element in composed music that makes it unique remains implicit; in addition, if the compiled music is emotional congruence, what is the difference between composed and compiled music could be a question need further investigation. The present project strived to contribute to these unknown aspects of soundtrack design in the following chapters.



Chapter 3. Soundtrack Design



In this chapter, the researcher first introduces the soundtrack elements that induce emotions. The audio-visual counterpoint, the relationship between characters and music (Leitmotiv), and the mode of music excerpts that are considered important in soundtrack design, and were further discussed. Following a practice of soundtrack design, including the story characters, theme, as well as the soundtrack design of *WaterBob*.

3.1 Soundtrack Elements Inducing Emotion

As Lalo Schifrin (2011), a professional score composer stated, the ultimate objective of the soundtrack is to psychologically support the film, no matter through what composing method.

“All the spectrum of emotions and mental states can be expressed by music.”, said Schifrin (2011, page). Many other composers and musicologists have also proposed numerous composing theories to validate how music induce emotion. Many score writers stressed the audio-visual relationship. The symbolic connection between characters and music (Leitmotiv) is as well emphasized. Other subtle elements including the orchestration and the harmony also need to be carefully designed through the composers’ keen intuition, artistic techniques, and a wealth of experience.

Among all the subtle details, composer Aaron Copland (1945) concluded four elements to listen for in music: rhythm, melody, harmony, and tone color. Other musicologists categorized the “music cues” with a more complex manner (Juslin and Lindström, 2010) (e.g., pitch, mode, melodic progression, rhythm, tempo, sound level, articulation, and timbre). How the music elements associated with the emotion has also been studied. Since all the elements are intercorrelated, it is challenging to determine the emotional induction of an individual music element (Eerola et al., 2013). Nonetheless, most of the studies agree with that mode and tempo

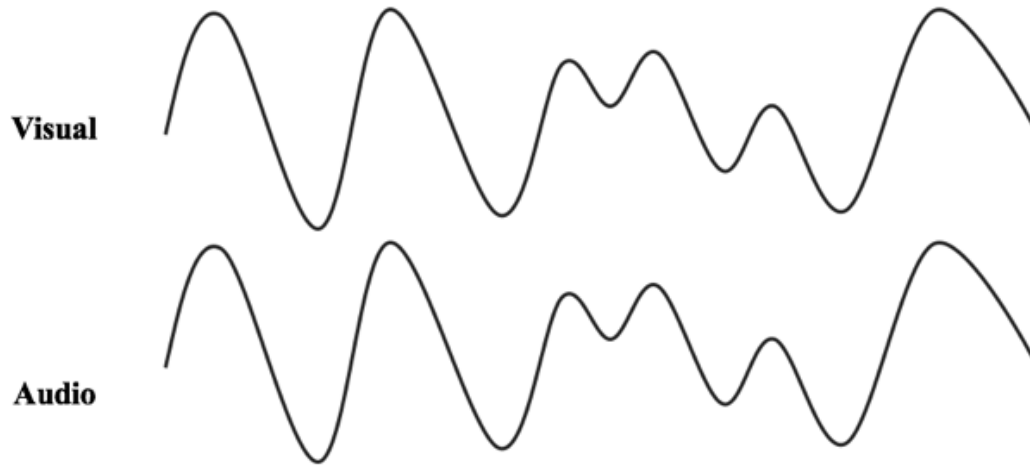
are the most critical factors for emotional reaction (Juslin and Lindström, 2010; Eerola et al., 2013), although the influence varies among different discrete emotions. As a result, in this paper researcher focus on analyzing the mode, particularly the melody and harmonic structure, in soundtrack design. As for the design of tempo and timbre, although were also carefully dealt with, are not the central issues in this paper due to the limited context.

3.2 The Audio-Visual Counterpoint

As stated by Schifrin (2011), the music composing counterpoint theory could be applied on the audio-visual relationship. The audio-visual relationship could be either parallel or contrary (Figure 1). Parallel counterpoint relationship is waterproof and more conservative, while contrary counterpoint relationship is rather excited and is often used in an ironic or reflective situation. Since most educational media propose critical questions iming to raise environmental awareness, the latter matches more in the case.



Parallel audio-visual counterpoint



Contrary audio-visual counterpoint

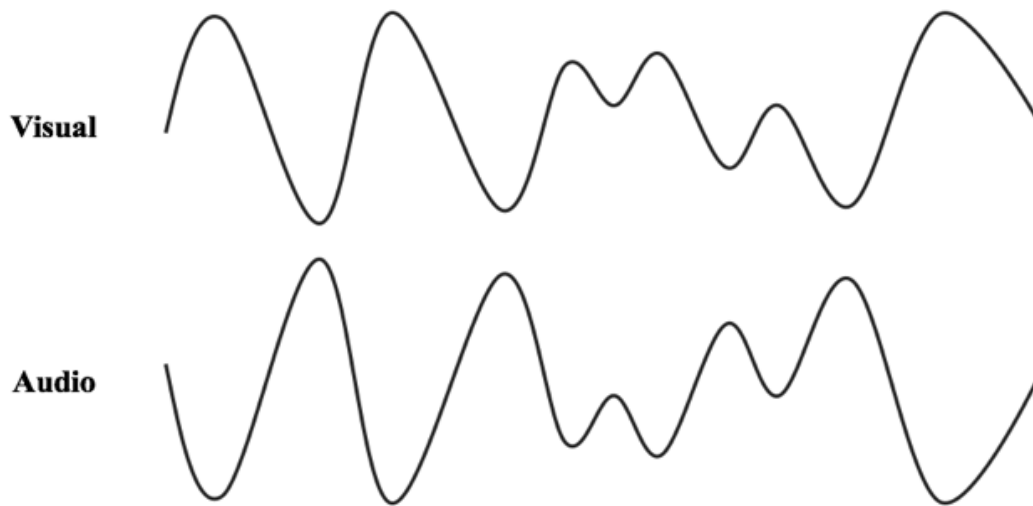


Figure 1 The audio-visual counterpoint

3.3 Leitmotiv

Leitmotiv (German, meaning leading motive) is a musical theme that accompanies a specific element in which it appears. A character, a location, or a unique situation in the plot could be accompanied by a leitmotiv to signal its unique meaning in a story. Richard Wagner is typically be regarded as the first one to use this idea. In his opera *Ring Cycle*, hundreds of leitmotifs were identified. Among all the themes, the most essential leitmotiv that represents the critical concept Rhinegold, repeats in the opera many times throughout the 4 mammoths. The theme appears in many different variations since the Rhinegold concept changes in the opera. In film industry, Star Wars is considered an indicator for applying leitmotiv. Each character, situation, and location all has unique themes. The theme for the lead role, Luke Skywalker, transformed from noble to sorrow, helps the audience to undergo emotion changes with Luke.

3.4 The Analysis of Mode

There are different ways to analyze the mode in music since the aesthetic values changes all the time. However, the mathematical analysis method used in the 20th century could be easily used to explain most of the music pieces existed. In the following section, Allen Forte's analyzing method for atonal music (1976) would be applied to elaborate the soundtrack design in the educational digital storytelling the researcher and her team created.

The color of Intervals

All melodies and harmonic structures in a mode, even those most complex ones, could be destructed to intervals. The distance between every 2 notes forms an interval. Since there are 12 different pitches in a sale, there could be 12 different intervals, from 0 semitone to 12 semitones. Trough transformation, the 12 intervals could then be reduced to 7 interval classes (0=0, 1=11, 2=10, 3=9, 4=8, 5=7, 6=6). The class 0 is omitted for practical purpose, leaving 6

intervals classes. As listed below, each interval class has its unique feature and emotional influences:

Class 1 (1 semitone), the minor second: It is the most dissonant interval. Harmonically, it provides a distinctive characteristic and could induce a terrifying feeling. One classic example was the theme song of *Jaws* composed by John Williams. The melody hovers around the E and F note, providing a feeling that "grinding away at you, just as a shark would do, instinctual, relentless, unstoppable." as described by Williams. In another example, "The Crisis" from *The Legend of 1900*, Ennio Morricone put a semitone below every mediant in triad. In this case, the minor second provides an anguished feeling symbolizing the tragic romance.

Class 2 (2 semitones), the major second: It is a slightly dissonant, emotionally neutral interval. If serving as the transformation of the minor seventh, it conveys a sense of hope and longing (Schiffirin, 2011). In Leonard Bernstein's "Somewhere" from *West Side Story*, the repeating major second expresses the desire for a better future for the lovers.

Class 3 (3 semitones), the minor third: All the third intervals are imperfect consonant. With a flowing quality, the thirds are often used as the motive power in music. The minor triad is the foundation interval in the minor triad and could express sadness, nostalgia, or the feeling of something lost (Schiffirin, 2011). A great number of examples from Beethoven's Symphony No.5 to "Summertime" from *Porgy and Bess* composed by George Gershwin would illustrate the emotion effect brought out minor third. The interval was also used in most of the musicology experiments as an association to sadness.

Class 4 (4 semitones), the major third: It is imperfect consonant, following the unison, the octave, and the perfect fifth in the order from consonant to dissonant. The major third is the foundation interval of the major triad and is commonly used to express positive emotions, from delightfulness to ecstasy. Examples including the major third (for example, Johann

Strauss II's Op.314 "The Blue Danube") were commonly used in musicology experiments as an association with happiness.

Class 5 (5 semitones), the perfect fourth: It is once considered consonant in the medieval polyphony stage since it formed the basis for music composition. Nonetheless, when the major and minor triads become the core element in music composition, the perfect fourth is then be considered dissonant. Nowadays, if the perfect fourth serves as the transformation of the perfect fifth, it is considered consonant; otherwise, it is dissonant. It provides a neutral, steady feeling with sometimes a crystal clear texture. It was used at the beginning of the "Bridal Chorus" from Wagner's *Lohengrin*.

Class 6 (6 semitones), the augmented fourth: Containing a tritone, the augmented fourth is the most intensive dissonant interval. Called "diabolus in musica" (the devil in music) in the Middle Ages, this interval contains overwhelming emotion that cannot be suppressed. It also has a strong tendency that leads to the perfect fifth. "Maria" from West Side Story (Leonard Bernstein) illustrated the burning desire provided by the augmented fourth.

The "Interval Vectors"

Introduced by Martino in 1961, the description of all the intervals in one combination of pitches is called an interval vector. Any pitch combination could be denoted as [ic1ic2ic3ic4ic5ic6] (ic is the abbreviation for the total number of a specific interval class). For example, the interval vector for the major triad is [001110] since there is 1 minor third (class 3), 1 major third (class 4), and 1 perfect (class 5).

The interval vector is like the color palette for a musician. With the interval vector, the color and emotion of a pitch combination could be further analyzed. For example, if the proportion of dissonant intervals is relatively more substantial, the emotion expression could also be more intensive.

3.5 Practices of Soundtrack Design

Our team joined On-line to On-site Water Education (O2O), a project of Ministry of Education. In O2O, audio books and games were created to deliver environmental concept about water resource preservation. Among them, the audiobook *WaterBob* was chosen to be used as a practice in this paper.

The theme of *WaterBob* is about limited water resource (full content in Appendix). The lead character, WaterBob, is the representation of either physical water, water storage facility, or water resource agency. Three other supporting characters relatively represent different water consumption parties: the *Mouse* (civil livelihood water), the *Cat* (industrial water), and the *Rabbit* (agricultural water).

WaterBob's duty was to collect water resource and distribute water resource to the 3 water consumers. In return, WaterBob got energy candy from the consumers. However, water demand increased. The priority of water distribution among different consumer parties became an issue. Moreover, water supply decreased due to droughts and pollution. WaterBob tried to negotiate with water consumers, yet none of them accepted getting less water or paying more energy candy. WaterBob was exhausted and could not supply water anymore. Not until then did the water consumers felt regret, but it was too late. WaterBob would never come back again.

As shown in Table 3, the structure of the story could be divided into 4 main sections and additional opening and ending section. In section 1, WaterBob distributed water to the consumers; in section 2, water demand increased and water supply decreased; in section 3, WaterBob tried to negotiate but was refused; In section 4, the consumers were regretful, but WaterBob would never come back. There is no plot in the opening and ending section. Only the soundtrack and a few pictures leads the viewers into the story in the beginning and last longer after the end of the story.

Opening	Section 1	Section 2	Section 3	Section 4	Ending
/	WaterBob distributed water to the consumers	Water demand increased and water supply decreased	WaterBob tried to negotiate but was refused	WaterBob would never come back	/

Table 3 Sections of *WaterBob*

3.6 Soundtrack Design of *WaterBob*

Music theories were applied to design the soundtracks of *WaterBob*. Although there were many aspects about soundtrack design, in this research we focus on the audio-visual relationship of the video and the main theme of each character.

The audio-visual counterpoint

The full audio-visual counterpoint relationship is shown in Figure 2. In the opening section, there is no plot but a picture of WaterBob bathing in the water. Music is the dominant element leading the viewers to immerse into the story, so the music is expressive and with an unclosed ending chord that arouses curiosity. Section 1 is the introduction of the story and the main characters, so there is not much tension in the music. Section 2 is where the main crisis arises, so the music twist dramatically to alert the audience. In section 3, the crisis keeps worsening. The tension in visual presentation and the audio narrative is high enough, so the sense of the presence of music decreases, leaving space for the visual and narrative information. In section 4, a critical issue is proposed. There is no music at all so the viewers will not be distracted. In the ending section, again there is no visual information. Nonetheless, that is when the viewer reflects what they have learned from the story. So the expressive music in the opening is used again to make the audience last longer in the immersion and think deeper.

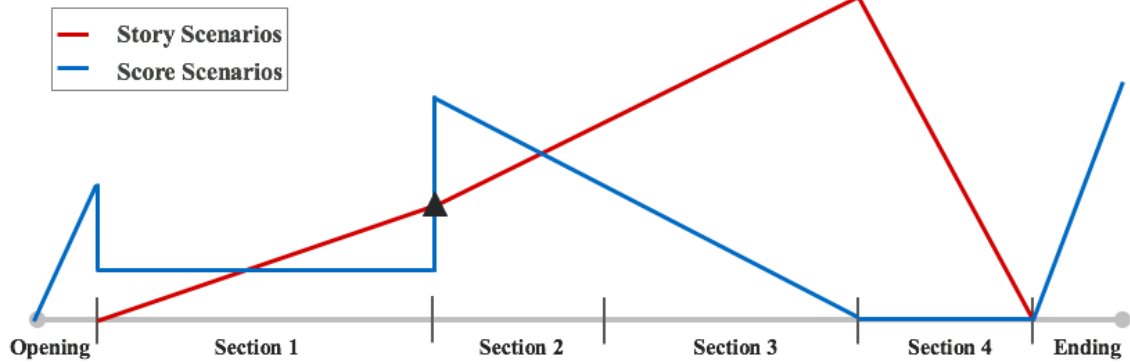


Figure 2 The audio-visual counterpoint of *WaterBob*

The leitmotifs and mode analysis

Leitmotiv could be applied to various elements: the characters, the environment, and even the meaning of the story. In *WaterBob*, however, Objective View Story (OVS) was applied, and personified objects are created to describe environmental issues from the object's view. In this case, the characters are the most essential element that should be emphasized. Therefore, the leitmotifs for each character were thus designed.

The instrument is designed according to the characteristic of each character, and the melody and harmony vary according to the plot and emotion expression in each section (full score in the appendix).

WaterBob

The lead character WaterBoB is a tender figure with curvy and crystal appearance. The soft and round timbre of the vibraphone is thus used to represent WaterBob. The leitmotiv for WaterBob is a 4-note descending scale, illustrating the flow of the river. The semitone between G and F sharp provides a little swaying feeling. As the story develops, the mode changes from major to minor and the number of interval classes 1 and 6 (minor second and augmented fourth) increases to reflect the stressful situation faced by WaterBob.

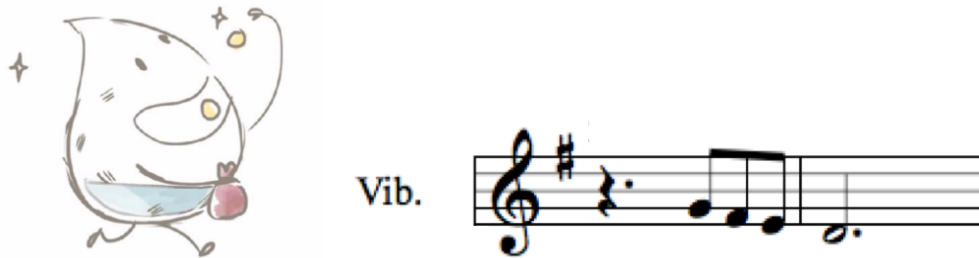


Figure 3 WaterBob and the leitmotiv

Characteristic	Instrument	Section Plot	Emotion Expression	Interval Vectors
Soft Tender	Vibraphone Electric piano	Water replenish	Peaceful	[101220](major form)
		Insufficient water	Worried	[101220](minor form) [122230] [212221](minor form)
		WaterBob dying	Pitiful	/

Table 4 The design of leitmotiv of WaterBob

The Mouse

The Mouse is a tiny bathing lover. A melody played by flute is just suitable to show the agility of the mouse and the association with water. The number of interval classes 1 and 6 (minor second and augmented fourth) increases to show the anger of the Mouse.



Figure 4 The Mouse and the leitmotiv

Characteristic	Instrument	Section Plot	Emotion Expression	Interval Vector
Small Bathing lover	Flute solo Clarinet Strings	Water delivery	Delightful	[001110](major form)
		Water delivery	Delightful	[001110](major form)
		Refusing more payment	Helpless	[202222] [001110](minor form)

Table 5 The design of leitmotiv of the Mouse

The Cat

Being the first customer asking for more water supply, the Cat plays the role of antagonist in the story. The bassoon is thus used to reflect the unctuous, conning characteristic of the Cat. The leitmotiv of the Cat has more dissonant intervals than the other characters at the beginning of the story. The most dramatic harmony (with the most dissonant intervals) appears in the second section where it is the turning point of the story.

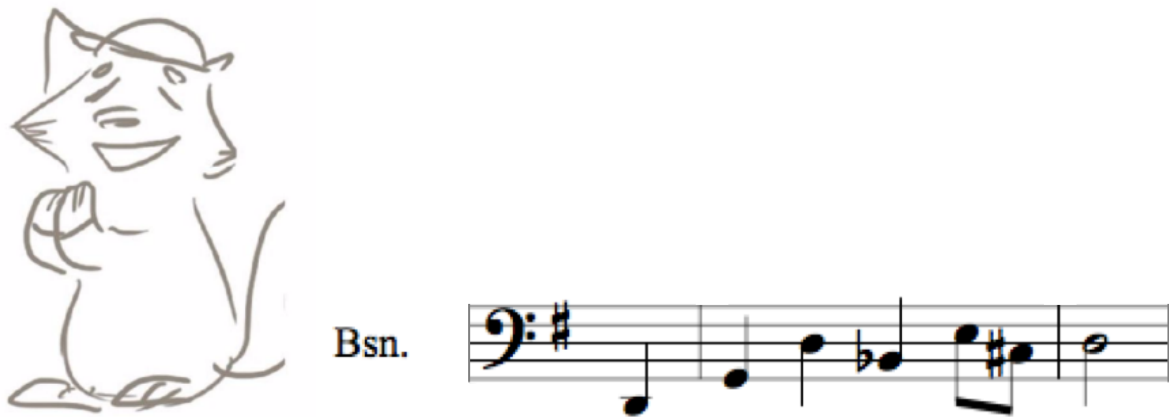


Figure 5 The Cat and the leitmotiv

Characteristic	Instrument	Section Plot	Emotion Expression	Interval Vector
Conning Profit-oriented	Bassoon solo Factory sound effects Cashier sound effects	Water delivery	Delightful	[114112] [111111]
		Demanding more water	Queer Alerted	[445332] [201021] [011110](minor form)
		Refusing more payment	Helpless	[114112] [323331] [111111](minor form)

Table 6 The design of leitmotiv of the Cat

The Rabbit

The guitar was chosen to show the pastoral feature of the Rabbit. The six-eight time rhythm illustrate the bouncy motion of the Rabbit. The most intensive plot happens in the second section where the Rabbit takes the lead to shout at WaterBob, so the interval vector contains more disconsonant intervals.



Figure 6 The Rabbit and the leitmotiv

Characteristic	Instrument	Section Plot	Emotion Expression	Interval Vector
Pastoral Bouncy	Guitar Strings Vibraphone	Water delivery	Delightful	[001110](major form) [011110](major form)
		Refusing less water	Anger	[001110](minor form) [211132] [012120] [402122]
		Refusing more payment	Helpless	[111120](minor form) [010101]

Table 7 The design of leitmotiv of the Rabbit

The Main Theme

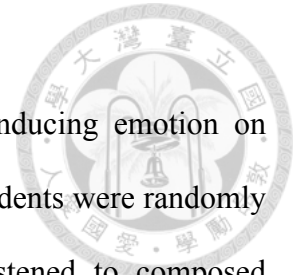
The video addressed a critical question: “How can we reach a balance between water supply and different demand customers?”. This question was not pointed out by any character, scene, nor plot, yet the audience could sense it within the story. A theme song was composed to emphasize the question and was placed at the beginning and the ending sections of the video. The theme song provided a sad atmosphere, with an open chord that gives the story a reflective feeling.

Instrument	Section Plot	Emotion Expression	Interval Vector
Electric piano	The Beginning The Ending	Reflective Sad	[001110] (minor form) [001110] (major form) [001110] (major form) [122230]

Table 8 The design of leitmotiv of the main theme

Chapter 4. Methodology

The present research investigates the effects of soundtracks inducing emotion on environmentally responsible behavioral intentions. Thirty-six college students were randomly assigned into two groups. While watching the video, one group listened to composed soundtracks, whereas another group listened to compiled soundtracks downloaded from online musical service platform, and simultaneously they were asked to provide their emotional reactions (positive, negative, or mixture) by pressing buttons. The data were collected by a researcher self-developed documenting tool and further analyzed by visualization tool.



4.1 The Educational Multimedia - *WaterBob*

Two sets of soundtracks, one is researcher self-composed while another is compiled one downloaded from online musical service platform, were added onto *WaterBob*, a digital storybook previous created by Yang (2017), from the same research team. *WaterBob*, a 10-minute digital storybook, was created in hopes of increasing learners' awareness of water conservation. In the composed group, the accompanying soundtracks were composed by the researcher following composing theories as described in chapter three; in the other group, the soundtracks were downloaded from online Creative Common music resources (music credit to Purple Plant

<http://www.purple-planet.com> and Youtube Audio Library

<https://www.youtube.com/audiolibrary/music>).

Since emotional congruence has been demonstrated to be an influential factor, the emotional expression of each download music excerpt was close to the corresponding composed soundtracks. Although there was plenty music in the CC resources, it is still challenging to find music excerpts expressing exactly the same emotion. Nonetheless, the researcher managed to find similar music segments with a slight degree of alternation. For

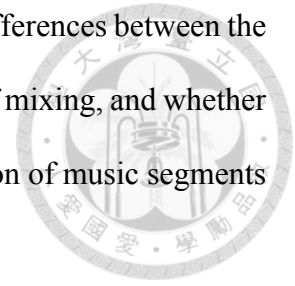
instance, two composed music segment for Cat triggered complex emotion (shown in Table 9), so the researcher could only use download music that was as close to the composed music as possible.



Section	Subsection	Composed music	Compiled music
Opening	/	Reflective	Reflective
Section 1	Mouse 1	Delightful	Delightful
	Cat 1	Delightful Queer	Delightful Magical
	Rabbit 1	Delightful	Delightful
	WaterBob 1	Peaceful	Peaceful
	Mouse 2	Delightful	Delightful
Section 2	Cat 2	Queer Alerted	Mysterious Alerted
	Rabbit 2	Anger	Anger Tense
	WaterBob2	Worried	Worried
Section 3	Rabbit 3	Helpless	Helpless
	Cat 3	Helpless	Helpless
	Mouse 3	Helpless	Helpless
	WaterBob 3	/	/
Section 4	Reflection	/	/
Ending	/	Reflective	Reflective

Table 9 The emotion expression of *WaterBob*

Having dealt with the emotion congruence issue, the remaining differences between the two music groups were the music style, the orchestration, and the space of mixing, and whether leitmotifs were designed. These difference further influenced the cohesion of music segments and the coherence of the story between the two groups.



4.2 Participants

In the first stage of the experiment, recruiting advertisements was posted on PTT, indicating the purpose, procedure and potential participants of the study with compensation of NTD 250 per test. The screening process was then conducted to select two similar groups to examine the intervention of composed soundtracks vs. compiled ones. In doing so, a self-developed online questionnaire using Google Form was released to select proper participants. The questionnaire includes 2 parts corresponding to the purpose of the present study, that is, to examine participants' emotional induction of soundtracks in educational multimedia toward water conservation issues. The first part of the questionnaire contains 4 questions. Every 2 questions measured *Environmental Awareness* and *Music Awareness* with 4 points grading scale (From 1 point, extremely disagree, to 4 points, extremely agree).

The Questions are listed below:

Environment Awareness

1. In general, I am aware of environmental issues.
2. I practice water conservation in daily life.

Music Awareness

1. Music influences my mood and feeling.
2. I am aware of the soundtracks while watching a video.

The average grade of questions 1 and 2 is then be defined as "*Environment awareness*", while the average of the grade of questions 3 and 4 be defined as "*Music awareness*".

The second part of the questionnaire asked the participants to provide emotional reactions towards video and music materials. The video material was *The Beans and the Water Fairies*, a three-minute water environment educational video developed by our team with composed music. The music material was an audio file composed of four music section download online (similar to the compiled soundtracks used in quantitative data collection) (music credit to Purple Plant

<http://www.purple-planet.com> and Youtube Audio Library

<https://www.youtube.com/audiolibrary/music>).

From the result of the screening questions, 36 subjects out of 100 respondents were selected and randomly divided into two groups, and the grade of *Environment Awareness*, *Music Awareness*, their emotions, and the sex ratio were balanced in both groups (Table 10).

Group	Group size	Environment Awareness	Music Awareness	Emotion response (film)	Emotion response (music)	Female: Male
Composed	18	3.00	4.00	29.16 times	24.66 times	12:6
Compiled	18	3.02	3.61	30.33 times	23.88 times	12:6

Table 10 Grouping Result

4.3 Data Collection

To serve the purpose of research, documenting tool as well as the following measurement tools were adopted to collect data. A visualization tool build up with Tableau was also utilized to collect and further analyze data.



Interactive Response

Since there are many sections in *WaterBob* inducing different emotional reactions, it is necessary to document the interactive responses from the viewers while watching the digital story.

Emotion Categories

Within literature, emotions are often classified into two categories: positive or negative emotions (Hinton et al., 2008; Schutz et al., 2006; Boltz, 2004). Although the emotional expressions in the segments of *WaterBob* are rich, in the experiment the researcher conclude all the expressions into 3 emotion types: *positive*, *negative*, and *mixture* (Figure 7). Although many musicology experiments use measurements that categorizes emotion to more than 3 categories (for example, the Geneva Emotion Wheel contains 20 emotion types), they are too complicated for this research. Since the interactive response is asked to be provided while watching the film simultaneously, the viewer may be distracted from the film when responding their emotion if there are too many emotion types to choose. With just three categories to choose, the distraction would not be slight and could be neglected.

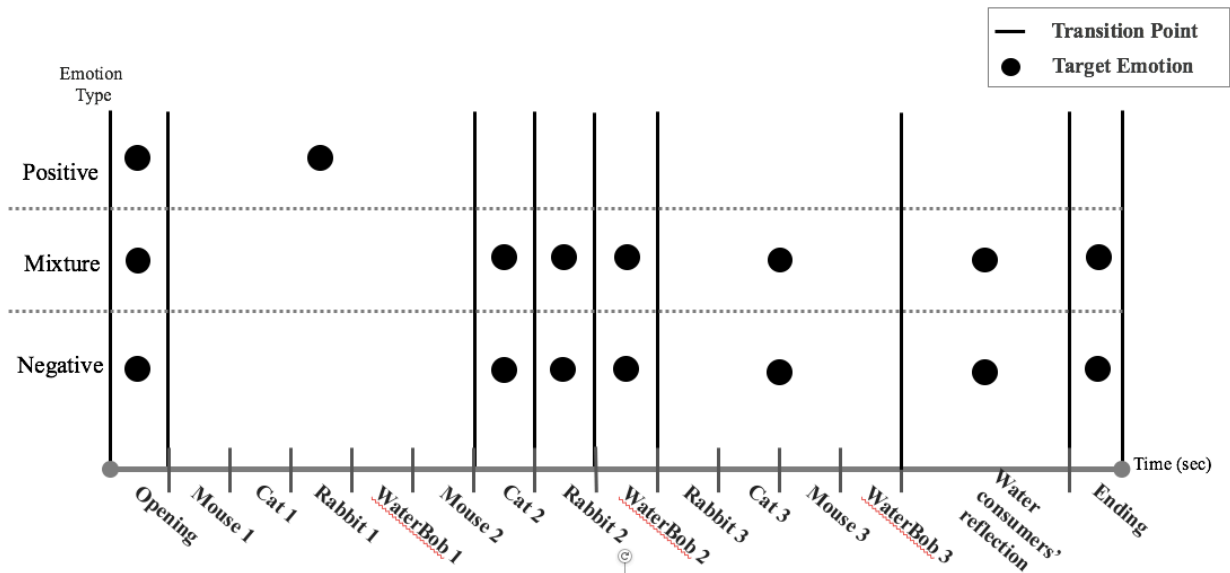


Figure 7 The emotion categories of WaterBob

Documenting Tool

A website (Figure 8) produced by *HTML* and *JavaScript* was designed for the respondents to record their emotional reactions while watching the material simultaneously. As shown below, 3 buttons (positive, negative, or mixture) were placed below a video player screen. Users could easily record their emotional reactions and the triggered times.



Figure 8 The documenting tool

Visualization Tool

An Excel file was specifically designed for the experiment. With the format prepared in advance, the data recorded from the documentary tool could be presented in figure immediately. The researcher could recognize the unexpected emotional responses right after the participants finishing watching the material, so the indication of those unexpected emotional responses could then be clarified during the interview.

For further analysis of the data, *Tableau Public* was used as the visualization tool. Tableau Public allows the researcher to analyze multidimensional data with various calculation functions and to present the data.

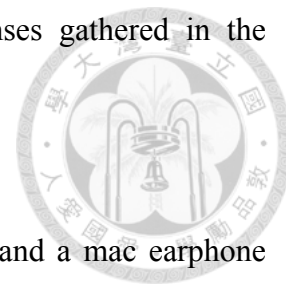
4.4 Experiment Design and Data Analysis

The purpose of the study is to exam whether composed soundtrack could significantly induce expected emotional responses. To answer the research question one, the *simple t-test*, also known as the independent samples t-test, was used for comparisons with a continuous dependent variable. In our case, participants were invited to watch two videos, composed vs. compiled ones. Simple t-test in SPSS 23 was used to provide full details of the t-test calculation, including sample mean, the sum of squares, and standard deviation.

4.5 Procedure

Upon arriving at the lab, the participants watched *WaterBob* with either composed or compiled soundtracks. Participants' emotional responses to soundtracks triggered by educational multimedia, the *WaterBob*, were collected. That is, interactive emotional reactions (positive, negative, or mixture) toward the material were asked to be provided simultaneously. After watching *WaterBob*, follow-up interviews were held to understand the details behind their responses. A set of questions were asked to know what the participants feel about the

visual and audio information. The meaning of the emotional responses gathered in the qualitative investigation was also specified in the interview.



Interactive Emotional Responses

The participants viewed the material individually. A Macbook and a mac earphone were used as the media. Before the investigation, the participants received the following instructions explaining task requirement:

Please press the buttons (Positive, Negative, or Mixture) which represent your emotional reaction while watching the video.

Positive: including but not limited to exciting, entertaining, delightful, passionate, encouraging...

Negative: including but not limited to nervous, angry, sad, fearful, guilty...

Mixture: all feelings that cannot be categorized into Positive nor Negative

Follow-up interviews

Since the emotion responses could only be categorized into 3 types, the exact meaning is vague. Thus, an interview is needed for the researchers to further explain the quantitative data. A self-designed question set was used in the interview. The question set can be divided into 3 parts: questions about the video and music, questions about the specific meaning of particular emotion reactions, and general questions. The first and second part of the questions were used to explain the quantitative result. The general questions were designed to get a clear view about what people think about the educational multimedia nowadays. Since in the experiment only one material was used, the researcher was interested in the participants' opinion and feelings toward other educational multimedia.

Question set

Questions about *WaterBob*

Do you remember any particular plot or music?

Is there any particular plot or music that you like/ dislike? Why?

What do you think about the plot design?

What do you think about the music design?



Questions about emotion reactions

Unexpected emotion reactions will be identified. The participants would be asked to explain what they feel that emotion at that time.

General questions

Have you ever watched education multimedia before?

If yes, could you briefly describe the theme and presentation of the multimedia?

How many detail could you still remember?

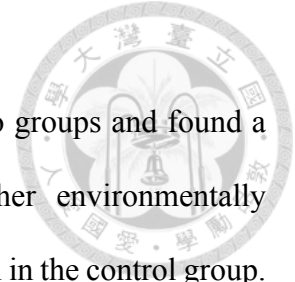
What's your feeling and reflection after watching that multimedia?

Is the multimedia knowledge driven or emotion driven? with real person or in animation?

Do you remember the background music in the multimedia?

Do you think the visual and audio matched each other?

Chapter 5. Results and Discussion



The researchers analyzed the emotion induction between the two groups and found a significant difference. Through a simple *t*-test, a significantly higher environmentally responsible behavioral intent was suggested in the intervention group than in the control group. The follow-up interview also showed a positive relation between emotional induce and environmentally responsible behavioral intentions.

5.1 The Heat Map of Emotional Induction

The emotional responses from individual participants are shown in Figure 9. Each strip represents one button hit from the participants. All the button hits were further gathered and summarized in Figure 10, which illustrates a more explicit emotion flow while watching the video.

Since the emotional settings for music in both groups, composed vs. compiled soundtracks, are the same, we can see that the overall emotional response pattern from the 2 groups is similar. However, with closer examination, it is found that there are some regions in which the participants answered unexpected emotional responses.

To further explain the details and specific phenomenon, the participants were asked to explain what is the meaning of those unexpected emotional. These follow-up interview data were used to further analyze the click data exhibit in the heat map. First, researcher recognized some *irrelevant* data; for example, two participants pressed “negative” when *Mouse*, one of the main characters in *WaterBob*, first came out. They reported that the reason they did that was because they were afraid of mice. This emotional response is not related to music design nor storyline. Some other participants reported negative responses about the narration or the breaking time were also identified and removed.

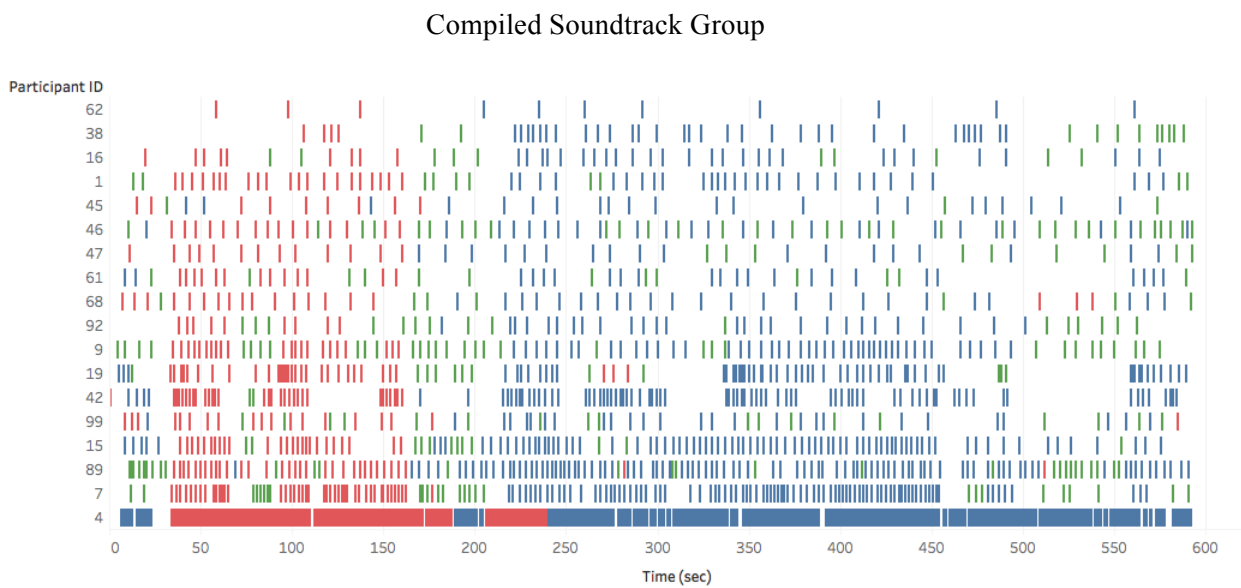
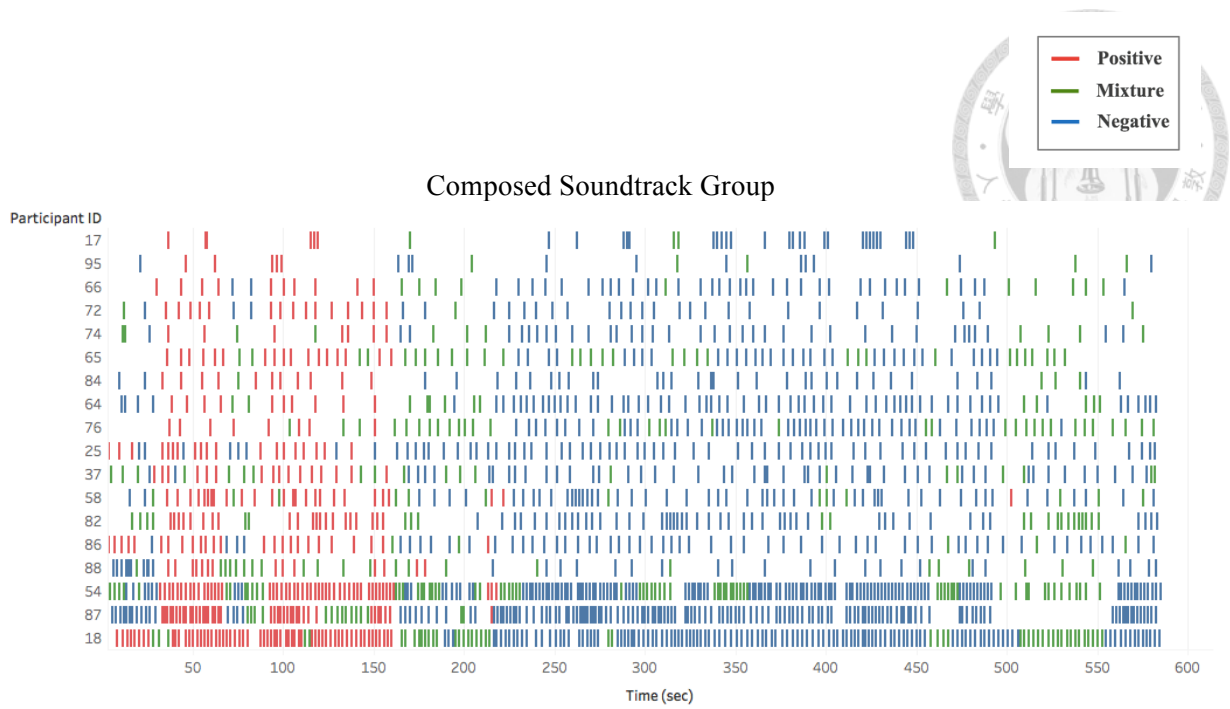


Figure 9 The heat map of emotional induction

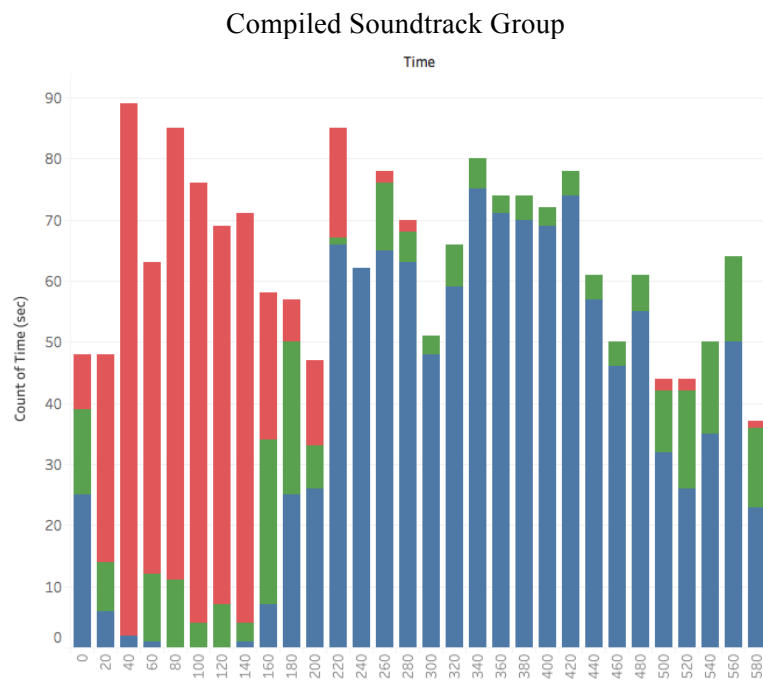
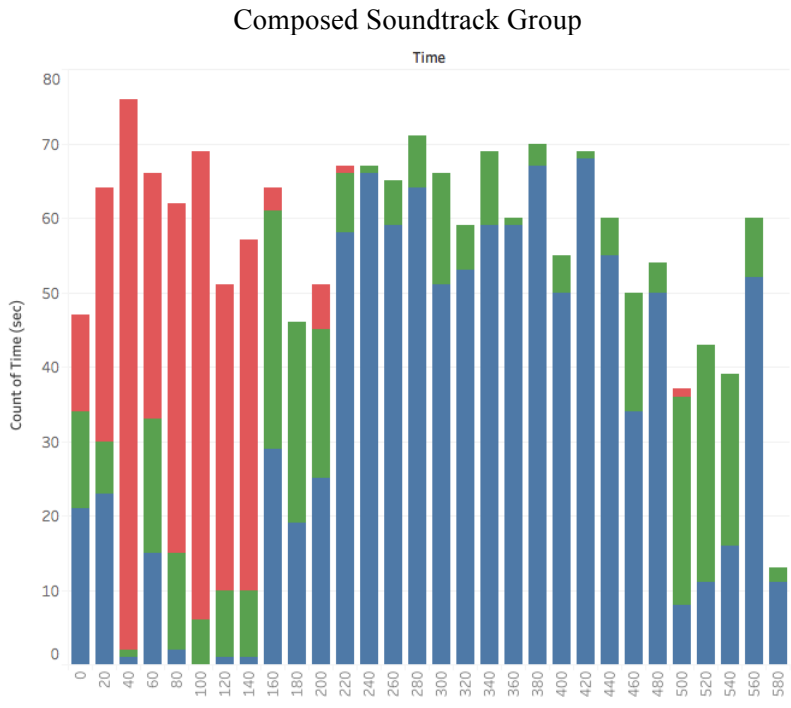


Figure 10 The emotional flow

After removing all the irrelevant data, all the unexpected emotional responses were summarized. Three particular sections in which the experiment group hits were identified as unexpected emotion (Figure 11). To be specific, the plot of the three sections are: (1) the *Cat* asked for more water supplement, (2) WaterBob cannot find water, and (3) the consumers felt regret about what they had done.

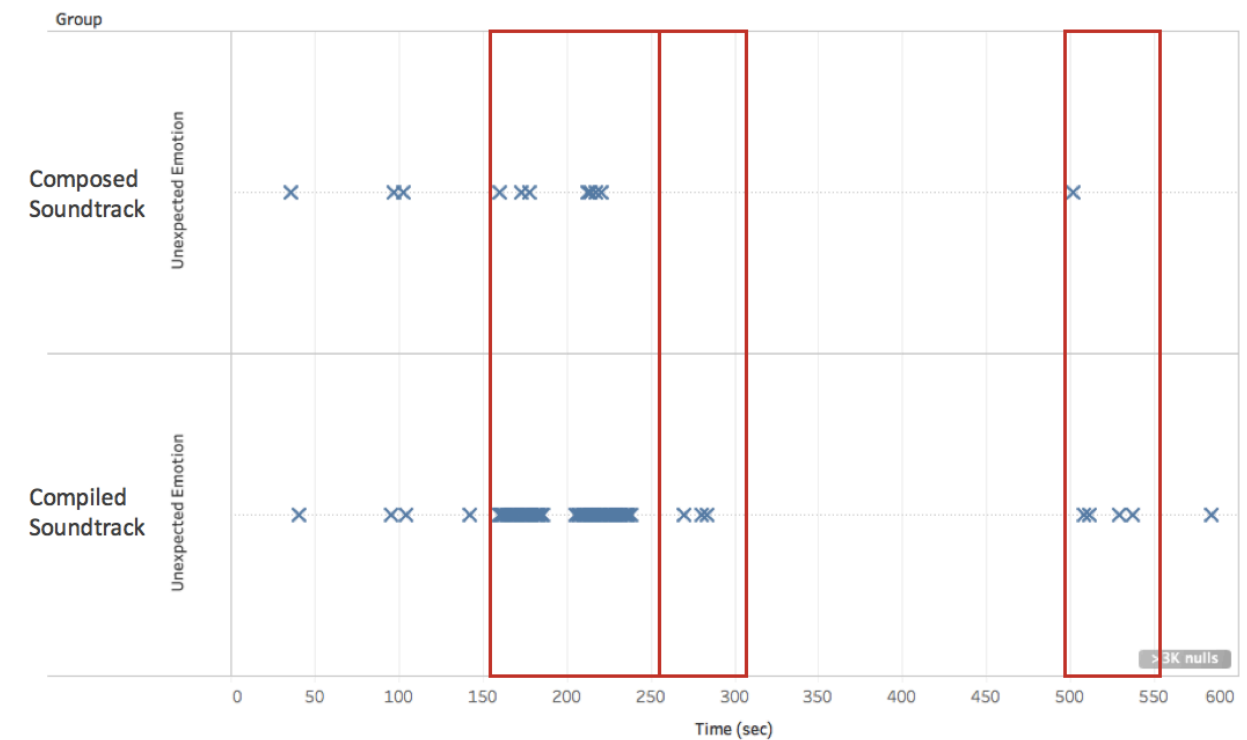


Figure 11 The unexpected emotion responses

From Figure 11 we can see that the hitting frequency varies in participants. To eliminate the influence caused by this difference, we use the below formula to normalize the data.

$$C = \sum \left(\frac{u_i \times e_t}{N \times e_i} \right) \quad (\text{Equation 1})$$

$$P = \frac{C}{e_t} \quad (\text{Equation 2})$$

Where:

C = count of unexpected emotion

P = Percentage of unexpected emotion

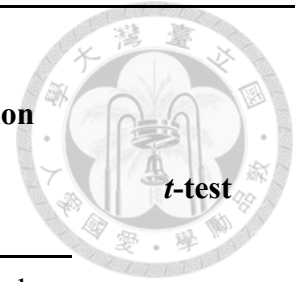
u_i = unexpected emotion response in the region (individual)

e_t = emotion response in the region (total)

e_i = emotion response in the region (individual)

N = group size

After eliminating the influence of differences on the count of emotion, the result is shown in Table 11. In the composed music group, the count of unexpected emotion in the three sections are 4.82, 0.00, and 0.00, all lower than those in the compiled music group which are 14.08, 9.95, and 7.30, with $t=3.02, 2.89, 2.53$, respectively, all of $p<.001$. For the percentage of unexpected emotion, in the composed music group are 3.30%, 0.00%, and 0.00%, all lower than those in the compiled music group who are 9.58%, 5.38%, and 5.29%. Both the count and percentage showed that the accuracy of emotional reaction is higher in the composed music group.



Section	Plot	Count of		Percentage of		<i>t</i> -test
		Unexpected Emotion (C)		Unexpected Emotion (P)		
		Composed music (n = 18)	Compiled music (n = 18)	Composed music (n = 18)	Compiled music (n = 18)	
1	The Cat asked for more water supplement	4.82 (1.22)	14.08(5.43)	3.30%	9.58%	$t = 3.02(p < .001)$
2	WaterBob cannot find water	0.00	9.95(2.65)	0.00%	5.38%	$t = 2.89(p < .001)$
3	Reflection of the consumers	0.00	7.30(1.09)	0.00%	5.29%	$t = 2.53 (p < .001)$

Table 11 The count and percentage of unexpected emotion (*t*-test)

Discussion

There are three sections in which the experiment group hits more unexpected emotion. From the interview, we found that in these sections the participants interpreted the story falsely; for example, in section one, participant no.4 reported “I felt happy for the *Cat* since it got more orders”; in section two, participant no.89 reported “I thought the polluted river is a hope for WaterBob”; in section three, participant no.19 and no.89 reported “I thought the animals were self-reflecting so maybe good things could happen”.

From the interview we may conclude that in the three sections, the “accuracy” of emotion triggered by the download soundtrack is lower than the composed soundtrack. Instead of following our designed storyline, the participants may interpret the story in their own way and ended up have false understandings of the story. To find the reason why unexpected happened mostly in these particular three regions, we further analyze the plot. In region one, Cat asked for more water supply, which is a turning point in the whole story; in region two, WaterBob could only find polluted water supply; in region three, the animals were self-reflecting, so it’s when the viewer could think about what they learned in the story.

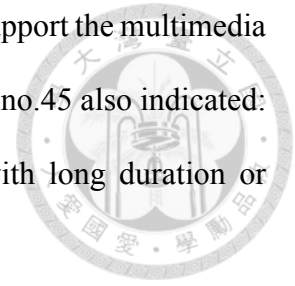
All of the plots were meaningful, with complex emotion, and could be interpreted variously. In regions like these three, composed music could guide the viewer’s emotion, ensuring they interpret the story the same way we want them to; in contrast, the download music could not support the plot as well as the composed music, thus could not guide the viewer’s emotion as good as in the other group.

Another feature these regions share in common is that they all contain complex emotion. Emotion is one of the most concerned factors in video production. In the previous section we have also mentioned that emotion setting of music is one of the control factors; however, even the website has already categorized the music into 20 types (upbeat, dance, cool, relaxing, reflective, sneaky, funky, cute, easy, creepy, rock, retro, jazz international, drama, tense, dark horror, and mysterious), far more than the three emotion type in our experiment design, we still could not find music that precisely fits the complex emotion combination in some of the plots.

5.2 Soundtrack Design Issues and Principles

Most participants considered the soundtracks as an essential factor in digital stories or educational multimedia. Participant no.4 and no.46 stated: “With the support of soundtracks, I felt easier to immerse in stories and thus understand the content better.” Participant no.25

provided an even stronger statement: “Soundtracks are like catalyst that support the multimedia even when the viewer is not aware of the audio information.” Participant no.45 also indicated: “Without soundtracks, I would not be willing to watch multimedia with long duration or complex content.”



However, corresponding to the problems stated in chapter one, participants show negative attitude toward the soundtracks in multimedia that they have viewed. As participants no.17 and no.89 stated, “No soundtrack would be better than low-quality soundtracks.” From the participants’ feedback on the *general questions* in the interview, the researcher concludes the following three issues in soundtrack design nowadays which are **emotional incongruence, modal incongruence, and lack of originality.**

Emotion incongruence

Participant no. 89 stated, “I had watched one multimedia in which the soundtrack provided a happy feeling when the characters were fighting with each other. I felt that soundtrack is very wired and distracting.” Participants no.18, no.37, no.46, and no.18 also indicated: “There are hardly any soundtracks in educational multimedia that provide negative emotion expression.” In other words, the soundtracks used in multimedia generally provide positive emotion expression, which could not fit in with negative plots.

Modal incongruence

Some other participants indicated that the style of visual and audio information do not match each other. Participant no. 17 and no.65 stated: “Some of the soundtracks I’ve heard are very outdated, making the film seemed like produced 30 years ago.” Participants no.64 stated: “It feels awkward to me when educational multimedia use soundtracks with vocal and lyrics.”

Lack of originality

Almost none of the participants could provide a clear description about soundtracks in educational multimedia. Although some of the participants could try to describe the soundtracks when encouraged by the researcher, their statements are “the soundtracks are similar to those in movies.” (no. 64), “It was just some soft music.” (no.18 and no.72), and “I think I have heard similar music in TV shows.” (no.99). Rather than their feeling or emotion, the participants use soundtracks in other multimedia to describe the educational soundtracks, indicating the soundtracks are lack of originality and infection.

Elements for Soundtrack Design

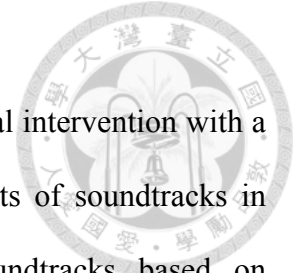
From the participants’ feedback, five essential factors were thus concluded for soundtrack design (Table 12). According to participants no.45 and no.64, the viewers are more likely to distract from the multimedia when the duration is long, more transitions in the soundtrack are thus needed to assist audience better immersed in the plot. Transitions are also important for multimedia with complex content as stated by participants no.65 and no.66. Soundtracks with positive emotional expression may also help understand complex content in educational multimedia (participants no.4, no.37, and no.65). Participants no.42 and no.45 stated that the texture of music should be more complicated if the plot is predictable, while the soundtrack(s) should be simple when important questions are provided by the multimedia to allow reflection and critical thinking. These statements correspond to the assumption that contrary audio-visual counterpoint should be applied on educational multimedia. Another audio element, the audio narration, should also be considered in soundtrack design. That is, the more emotion and words in the narration, the less should the soundtrack be. Finally, the viewing occasion would also influence soundtrack design. When viewing the multimedia alone or online, the emotional influence of the soundtracks is more essential than viewing in class.



Elements of multimedia	Soundtrack Design Principles
Duration	More transitions are needed in the soundtracks when the duration of the film is longer.
The difficulty of the content	(a)When the content of the film is challenging, more transitions are needed in the soundtracks. (b) Positive emotional expression in the soundtracks helps the viewers understand challenging content.
Predictability of the plot	The texture of the music should be more complex if the plot is easy to predict.
Amount of the audio narration	The more the audio narration is, the less should the soundtracks be.
Viewing occasion	When viewing the multimedia alone or online, the emotional influence of the soundtracks is more critical than viewing in class.

Table 12 Elements of soundtrack design

Chapter 6. Conclusion

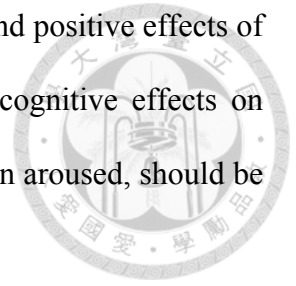


In the present study, the researcher developed a novel experiential intervention with a purpose to extend our understanding of the emotional induction effects of soundtracks in educational multimedia. Specifically, the researcher developed soundtracks based on composing theories. In addition, one of the unique contributions is the introduction and interpretation of audio-visual counterpoint, the relationship between characters and music (Leitmotiv), and the mode of music.

Based on our preliminary analysis exhibit on heat maps, two results converged. First, compared to compiled soundtracks, intentionally design ones significantly induced emotions in most sections and plots. Second, intentionally design soundtracks are meaningfully going along with digital stories, especially when they are designed based on composing theories. In addition, the follow-up interview also indicated that most of the participants recognize the value of adding soundtracks to educational multimedia, and further proved to be an effective strategy for promoting intention to actively engage in pro-environmental activities.

A lingering question is the connection between each response to different types of educational multimedia. Specifically, if the scenarios and plots changed, the soundtrack design method remain unclear. Limitations of the experiment design were noted in two aspects: the sample selected and the frequency of intervention. The sample, consisting of 67% female college students, could limit the generalizability of the results. Gender may cause differences in their emotional responses. Indeed, the measures process and calculating of interactive emotional responses were designed arbitrarily by the researcher and research team, that could be further elaborated. To yield further insight into the effectiveness of the water conservation in the context of environmental education, future research should recruit a broader range of participants from different populations. In addition, the outcomes of repeated interventions, e.g. composed soundtracks going along with different types of digital stories, and measurements of

the environmental behavior have to be considered. The current study found positive effects of interactive emotional response, but the psychological model, such as cognitive effects on attitude or behavior intention, and the extent of responsibility and emotion aroused, should be investigated in detail.



Reference



- Barret, H. C. (2006). Researching and evaluating digital storytelling as a deep learning tool. Proceedings of the Society for Information Technology & Teacher Education International Conference, Chesapeake, VA, pp. 647-654.
- Baumgartner, T., Lutz, K., Schmidt, C., & Jäncke, L. (2006). The emotional power of music: How music enhances the feeling of affective pictures. *Brain Research*, 1075(1), 151-164.
- Berenguer, J. (2007). The effect of empathy in proenvironmental attitudes and behaviors. *Environment and Behavior*, 39(2), 269-283.
- Boltz, M., Schulkind, M., & Kantra, S. (1991). Effects of background music on the remembering of filmed events. *Memory & Cognition*, 19(6), 593-606.
- Boltz, M. (2001). Musical soundtracks as a schematic influence on the cognitive processing of filmed events. *Music Perception*, 18(4), 427-454.
- Boltz, M. (2004). The cognitive processing of film and musical soundtracks. *Memory & Cognition*, 32(7), 1194-1205.
- Bullerjahn, C., & Güldenring, M. (1994). An empirical investigation of effects of film music using qualitative content analysis. *Psychomusicology: A Journal of Research in Music Cognition*, 13(1-2), 99-118.
- Cheng, Y., Lou, S., Kuo, S., & Shih, R. (2013). Investigating elementary school students' technology acceptance by applying digital game-based learning to environmental education. *Australasian Journal of Educational Technology*, 29(1).
- Cohen, A. J. (1999). The functions of music in multimedia: A cognitive approach. In S. W. Yi (Ed.), *Music, mind, and science* (pp. 53-69). Seoul, Korea: Seoul National University Press.
- Cohen, A. J. (2001). Music as a source of emotion in film. In P. Juslin & J. Sloboda (Eds.), *Music and emotion* (pp. 249-272). Oxford, UK: Oxford University Press.
- Copland, A. (1939). *What to listen for in music*. New York: Whittlesey House.
- Eerola, T., Friberg, A., & Bresin, R. (2013). Emotional expression in music: contribution, linearity, and additivity of primary musical cues. *Frontiers in Psychology*, 4.
- Farmer, J., Knapp, D., & Benton, G. (2007). An elementary school environmental education field trip: Long-term effects on ecological and environmental knowledge and attitude development. *The Journal of Environmental Education*, 38(3), 33-42.

Forte, A. (1973). *The Structure of Atonal Music*. New Haven and London: Yale University Press.

Hevner, K. (1936). Experimental studies of the elements of expression in music. *The American Journal of Psychology*, 48(2), 246.

Hill, J., & Nelson, A. (2011). New technology, new pedagogy? Employing video podcasts in learning and teaching about exotic ecosystems. *Environmental Education Research*, 17(3), 393-408.

Hinton, C., Miyamoto, K., & Della-Chiesa, B. (2008). Brain research, learning and emotions: implications for education research, policy and practice1. *European Journal of Education*, 43(1), 87-103.

Juslin, P. N., and Lindström, E. (2010). Musical expression of emotions: modeling listeners' judgements of composed and performed features. *Music Analysis*. 29, 334–364.

Kalinak, K. (1992). *Settling the score*. Madison, Wis: Univ. of Wisconsin Press.

Kuo, K. L. (2013). Is a computer game a positive motivation trigger for disaster education? A flood protection game example (Master's thesis). Available from

Lipscomb, S., & Kendall, R. (1994). Perceptual judgement of the relationship between musical and visual components in film. *Psychomusicology: A Journal of Research in Music Cognition*, 13(1-2), 60-98.

Perrin, J. (2011). Emotional Responses to Environmental Messages and Future Behavioral Intentions. *Applied Environmental Education & Communication*, 10(3), 146-157.

Philips, W. (2014). *A Composer's Guide to Game Music*. London, England: The MIT Press.

Rigg, M. (1964). The mood effects of music: A comparison of data from four investigators. *The Journal of Psychology*, 58(2), 427-438. <http://dx.doi.org/10.1080/00223980.1964.9916765>

Robin, B. (2006). The educational uses of digital storytelling. In C. Crawford et al. (Eds.), *Proceedings of Society for Information Technology and Teacher Education International Conference* (pp. 709-716). Retrieved from <http://faculty.coe.uh.edu/brobin/homepage/Educational-Uses-DS.pdf>

Scherer, K. (1978). Personality inference from voice quality: The loud voice of extroversion. *European Journal of Social Psychology*, 8(4), 467-487.

Schifrin, L. (2011). *Music Composition for Film and Television*. Boston, USA: Berklee Press.

Schutz, P., Hong, J., Cross, D., & Osbon, J. (2006). Reflections on investigating emotion in educational activity settings. *Educational Psychology Review*, 18(4), 343-360.

Slattery, P., & Rapp, D. (2003). *Ethics and the foundation of education*. Boston: Allyn & Bacon.

doi:10.6342/NTU201801179

Thompson, W., Russo, F., & Sinclair, D. (1994). Effects of underscoring on the perception of closure in filmed events. *Psychomusicology: A Journal of Research In Music Cognition*, 13(1-2), 9-27.

Yang, S. H. (2017). Object View Story: Changing Environmental Attitude by Stimulating Emotional Arousal in Water Education (Master's thesis). Available from <http://www.airitilibrary.com>.

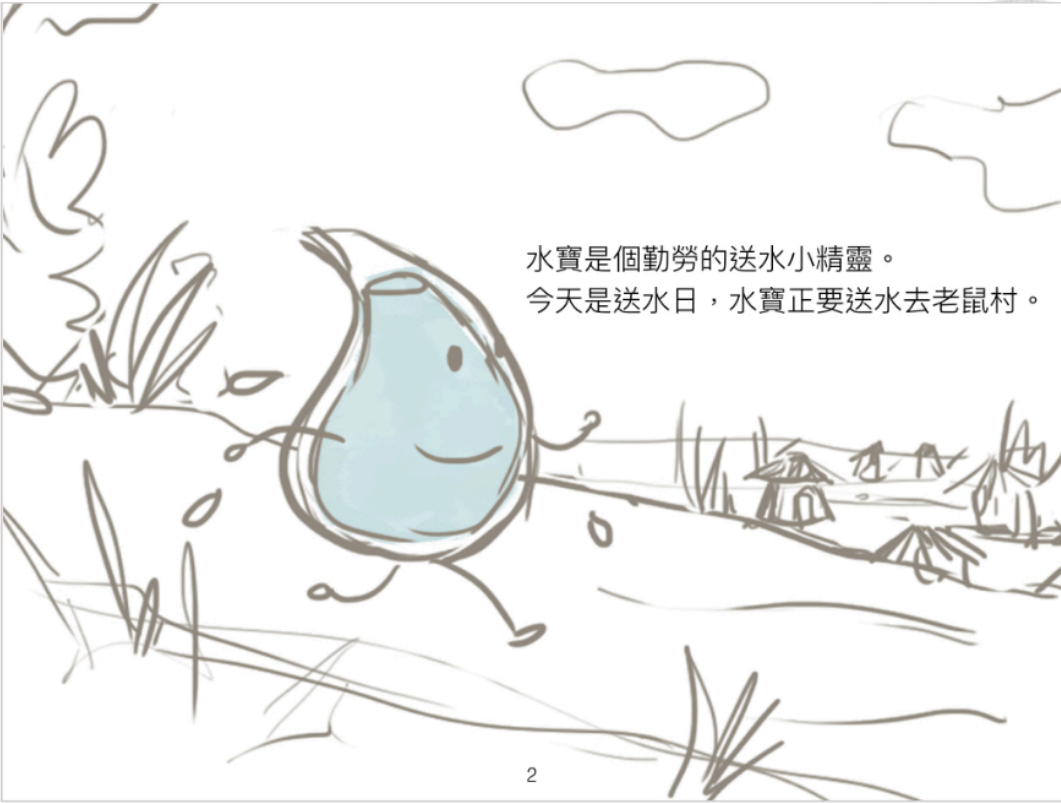


Appendix 1

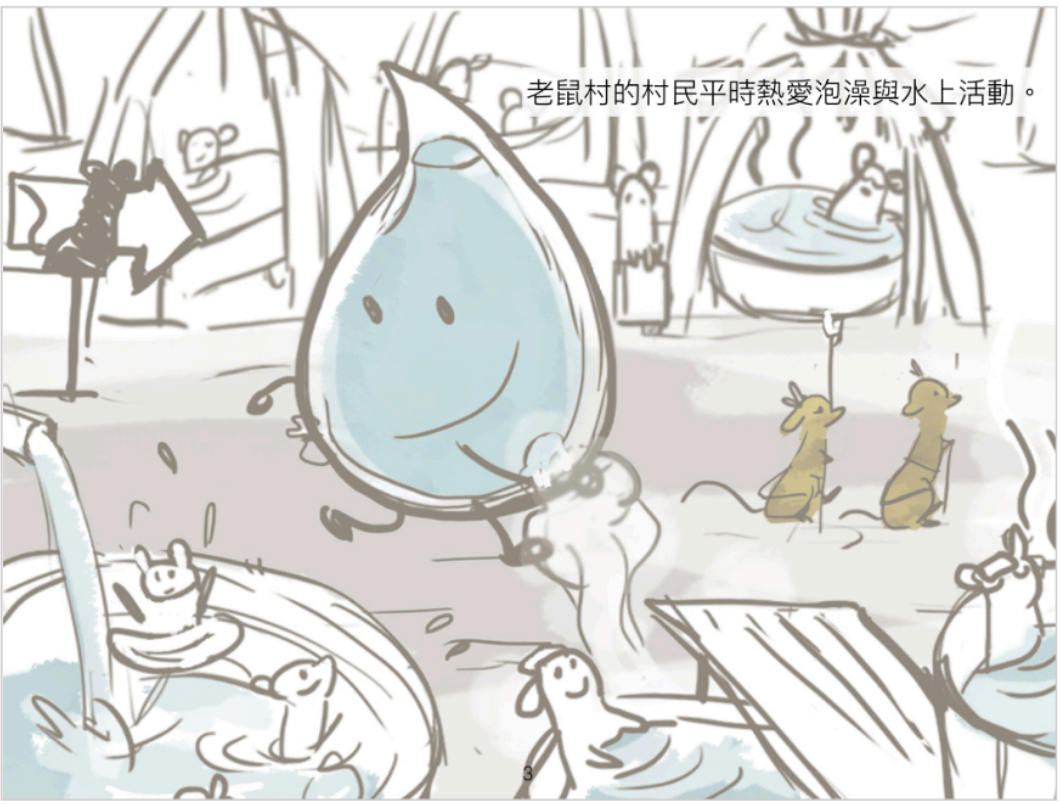


Full content of *WaterBob* (available online: <http://water.caece.net/382633069335672.html>)





水寶是個勤勞的送水小精靈。
今天是送水日，水寶正要送水去老鼠村。



老鼠村的村民平時熱愛泡澡與水上活動。

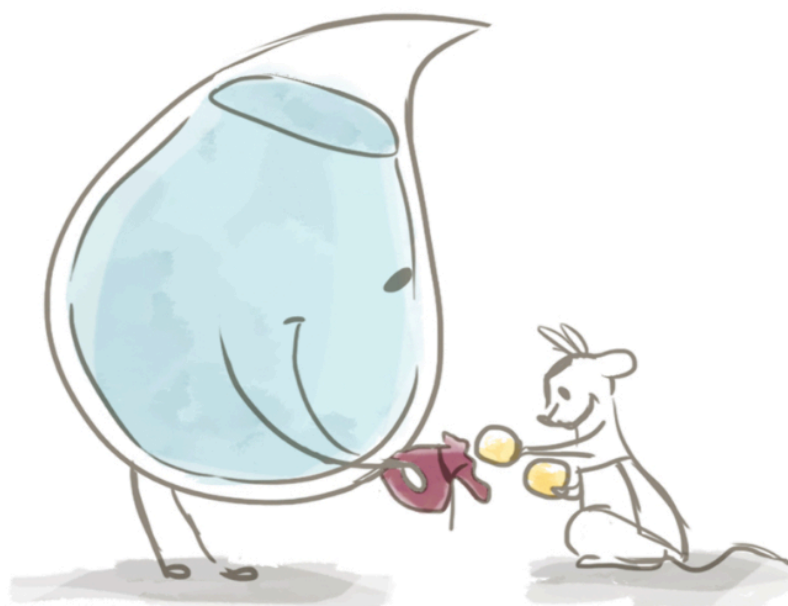


老鼠頭目已準備好兩個空桶子等著水寶。
「我們的泡澡水就靠你了！」

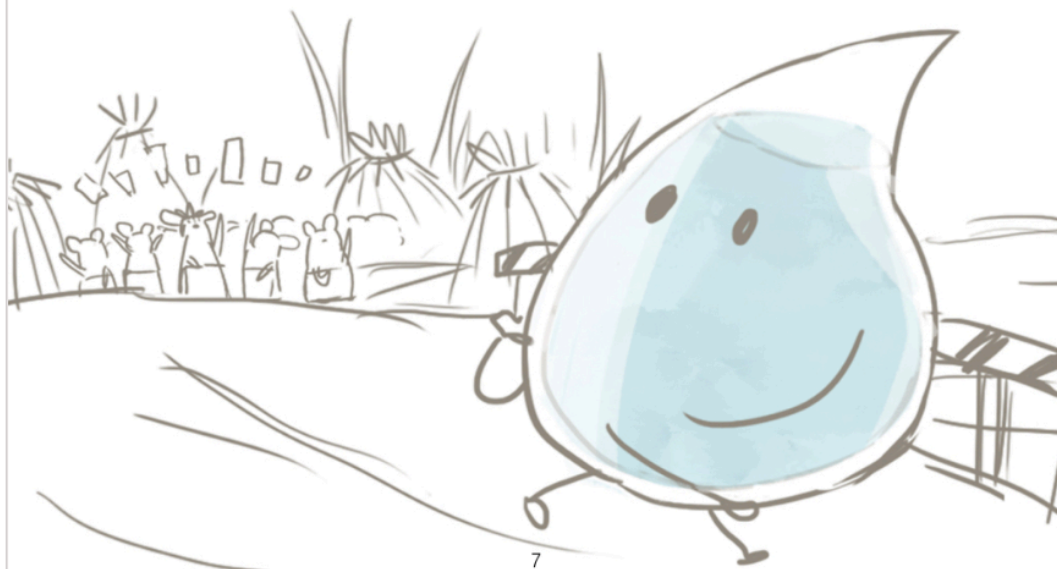


水寶雙手一變，
將兩個空桶子裝滿了水。

一桶水一顆糖。
頭目給了水寶兩顆糖果作為回報。



互相道謝後，水寶便前往貓咪工廠。



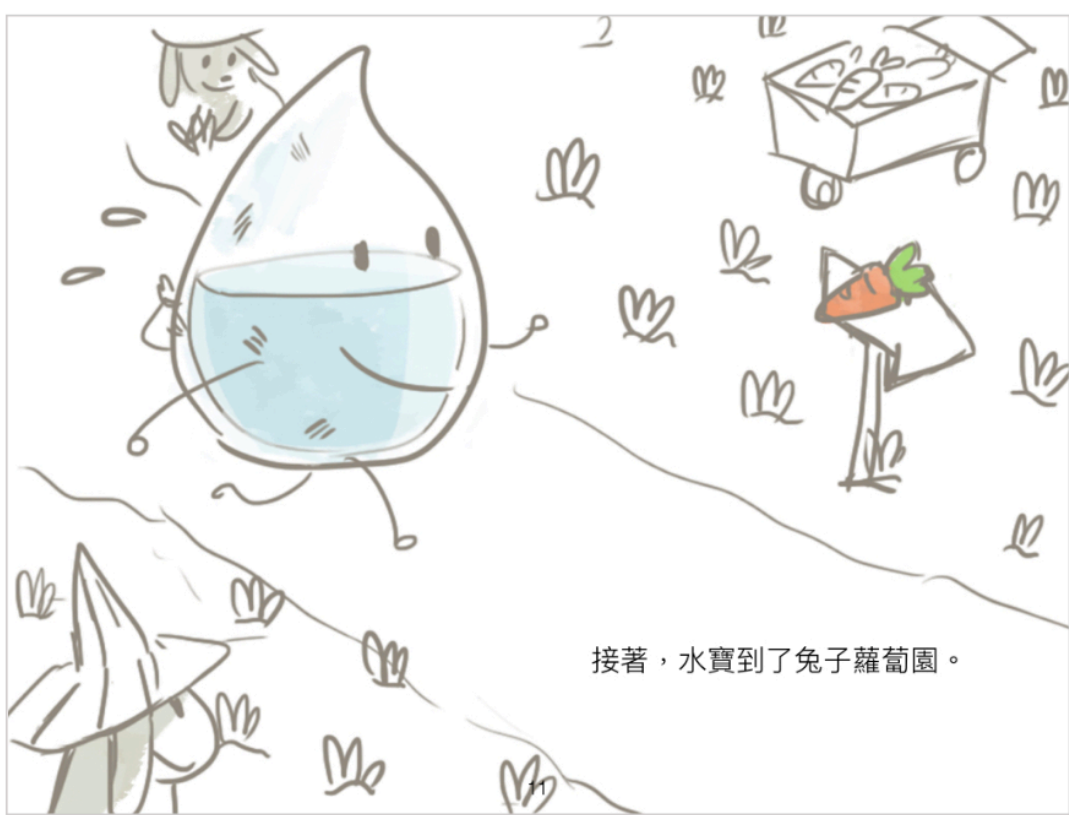


水寶到了貓咪工廠。
這裡生產各種生活用品。

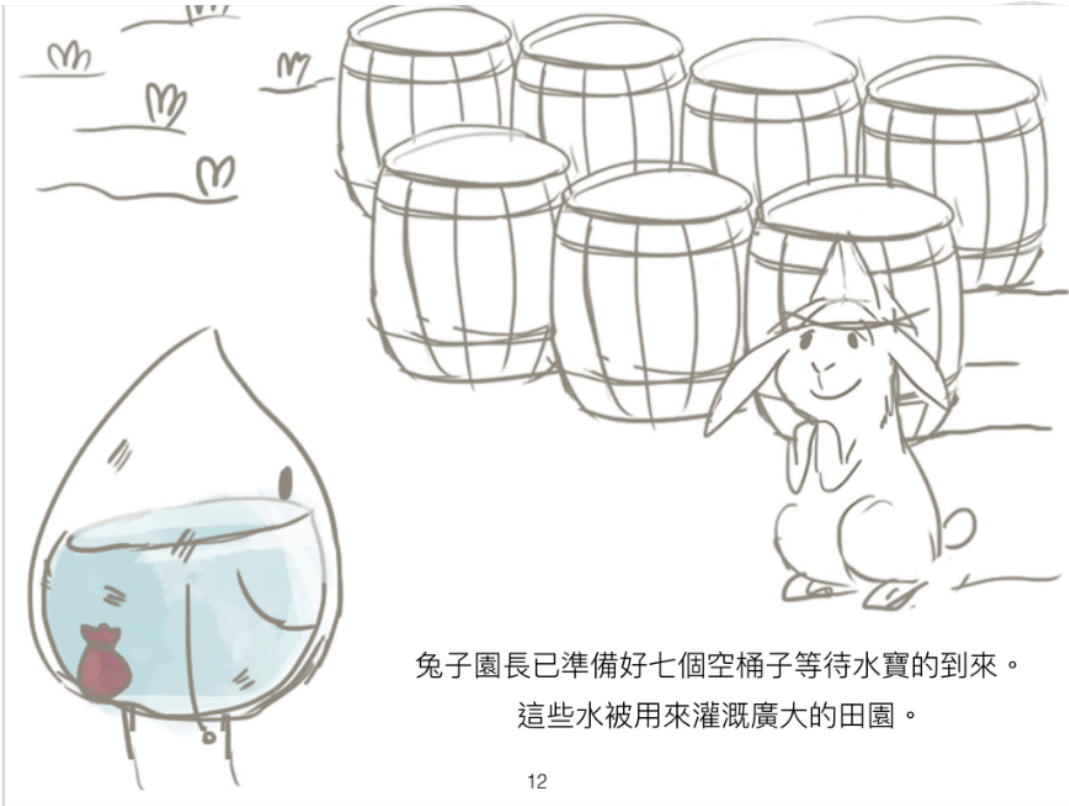


貓老闆已經準備好一個空罐子等著水寶。
這罐水用於蒸汽機的運作，
是工廠一切動力的來源。

一罐水一顆糖，水賣收下了貓老闆一顆糖果的回報。



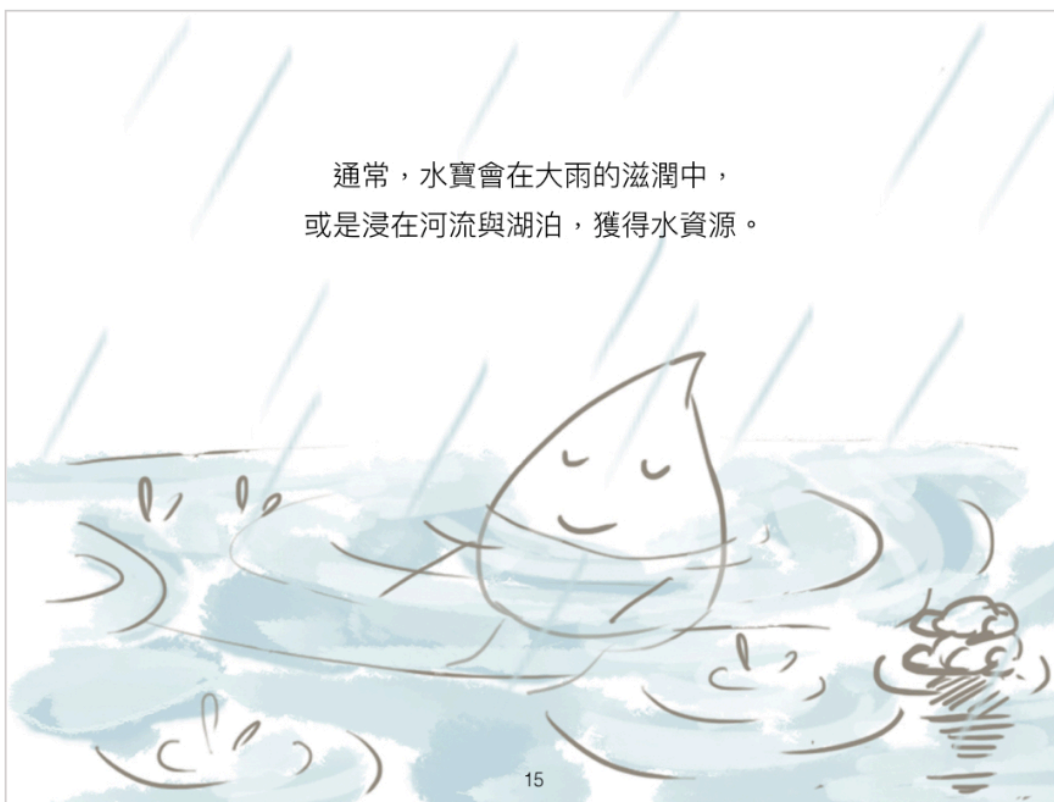
接著，水賣到了兔子蘿蔔園。



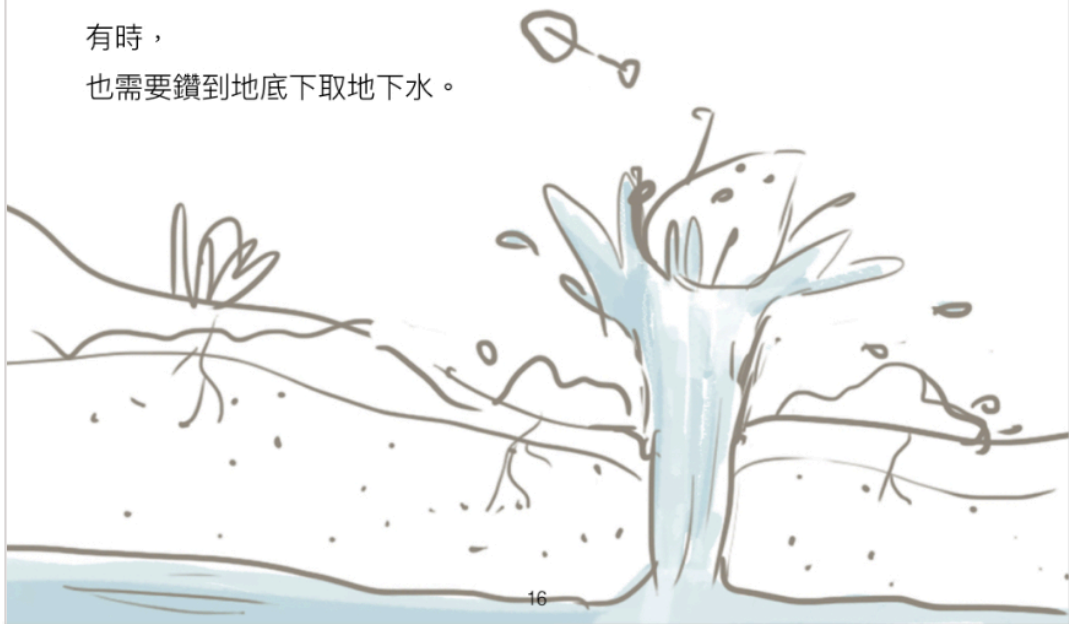
忙碌的送水行程終於結束了。
水寶吃起可以補充滿滿能量的糖果。
體力與精神恢復了以後，就要為下一次的送水日，搜集水資源了。



通常，水寶會在大雨的滋潤中，
或是浸在河流與湖泊，獲得水資源。



有時，
也需要鑽到地底下取地下水。



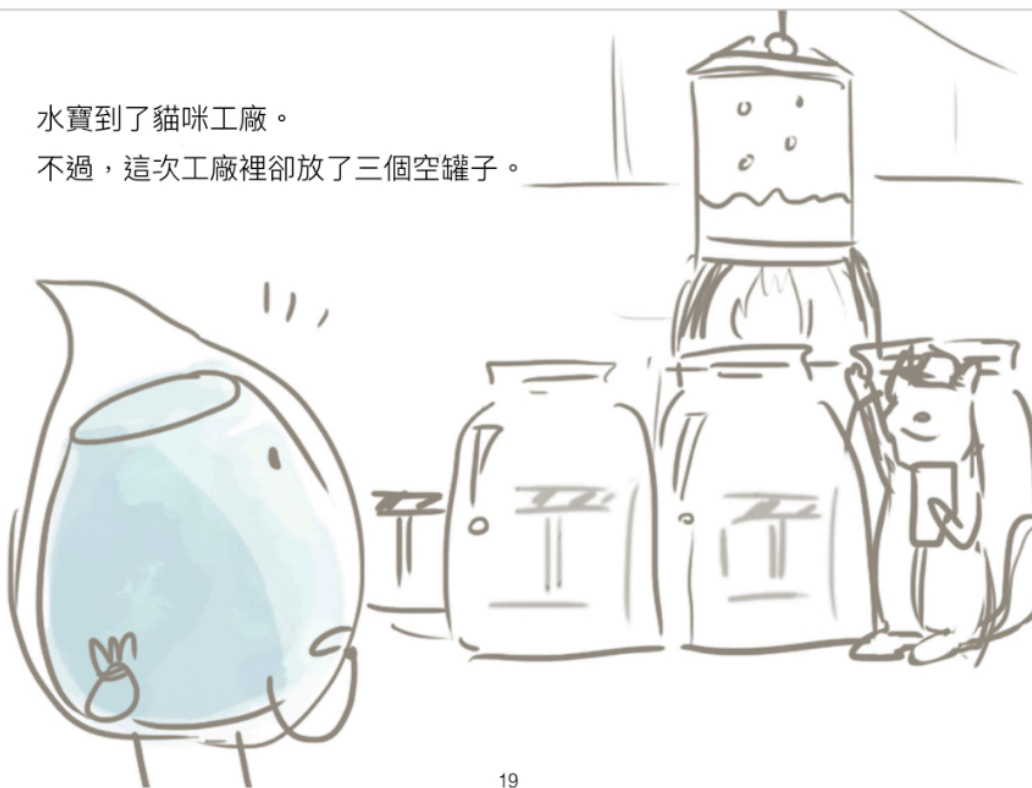
又到了送水的日子，
水寶準備好滿滿的水，進入老鼠村。



一如往常，水寶裝滿老鼠村的兩桶水，
獲得了兩顆糖果的回報。



水寶到了貓咪工廠。
不過，這次工廠裡卻放了三個空罐子。



「最近生意不錯，接到一大筆訂單，需要更多的水來維持工廠的運作，今天可以多給我兩罐水嗎？」

貓老闆請求。

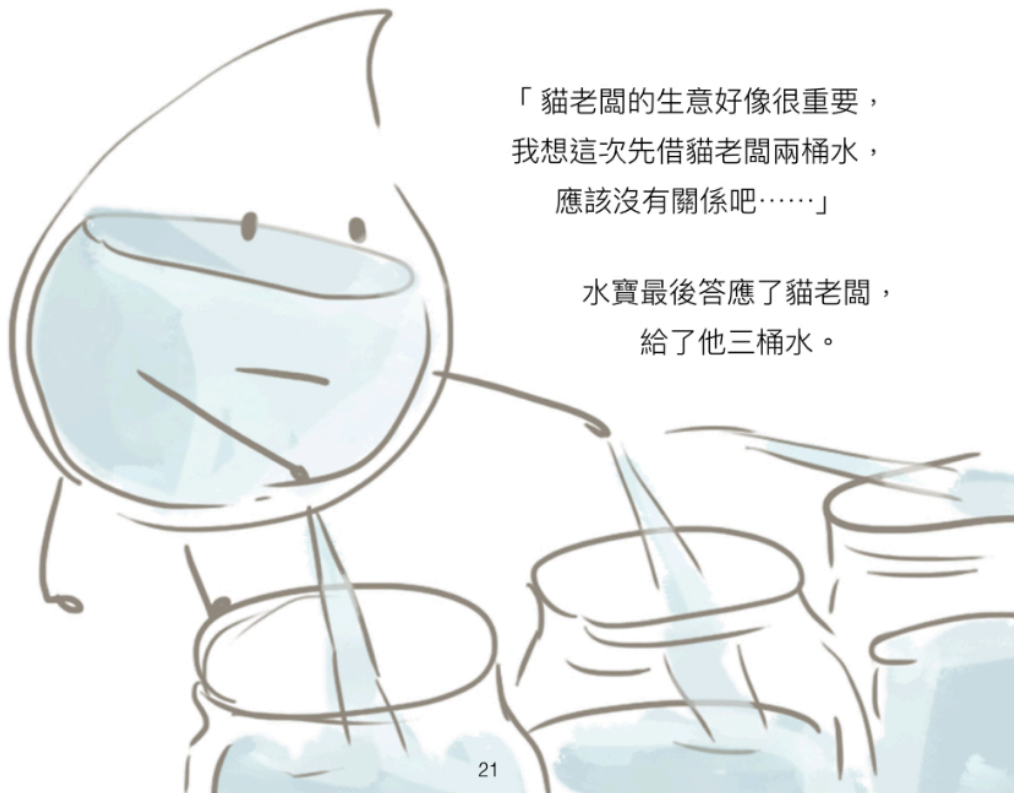
「可是，等等還要送七桶水給蘿蔔園……」

水寶猶豫的看著肚子思索著。



「貓老闆的生意好像很重要，我想這次先借貓老闆兩桶水，應該沒有關係吧……」

水寶最後答應了貓老闆，
給了他三桶水。



水寶得到了貓老闆的三顆糖果，前往兔子蘿蔔園。

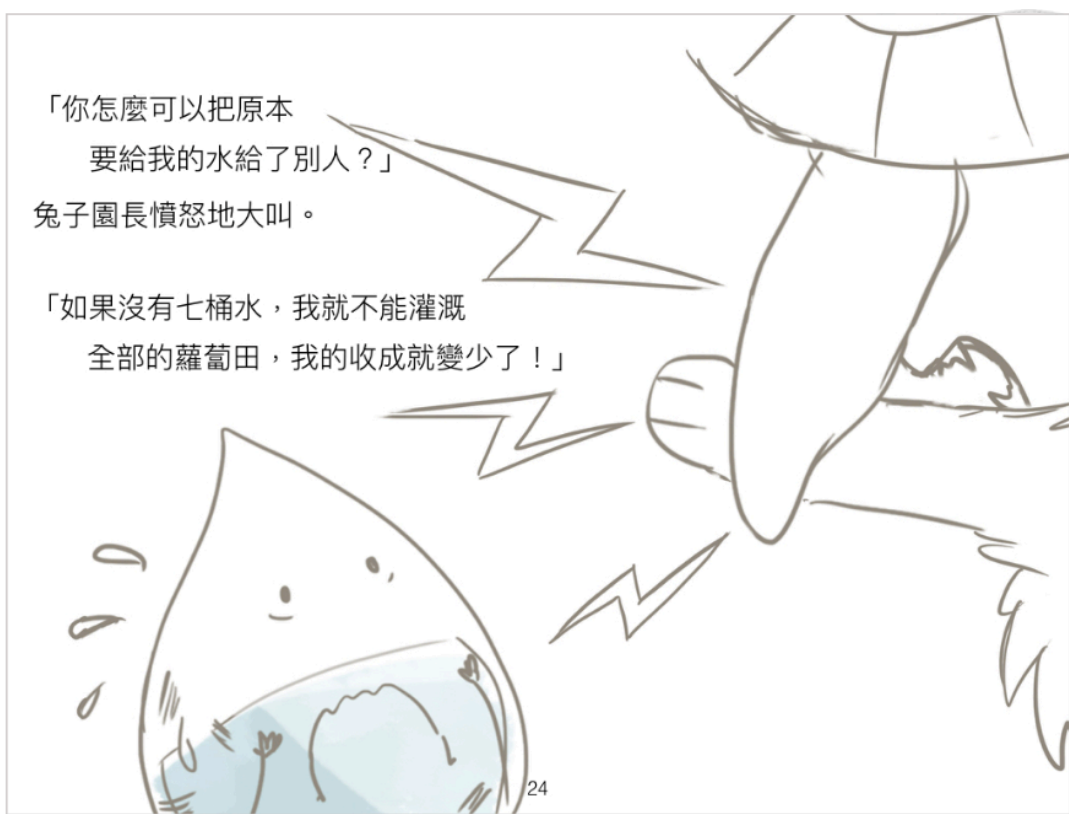


「園長，很抱歉，貓老闆因為工廠需要，多向我要了兩罐水……而我準備的水不夠多，今天恐怕只能給您五桶水了。」
水寶道歉並解釋。



「你怎麼可以把原本
要給我的水給了別人？」
兔子園長憤怒地大叫。

「如果沒有七桶水，我就不能灌溉
全部的蘿蔔田，我的收成就變少了！」



「下一次的送水日，
你要第一個先來我這，
記得準備多一點水！」

水寶給了兔子五桶水後，
領了五顆糖果，感到抱歉地離去。



水寶開始焦急地尋找水資源。
為了滿足大家的需求，水寶必須準備更多的水。



不料，已經好多天沒有下雨了。
溪河和湖泊的水位比平常還要低。



地下水也已經用盡了。



為了尋找新水源，
水寶長途跋涉到不同地方。
他找到了一個河川。



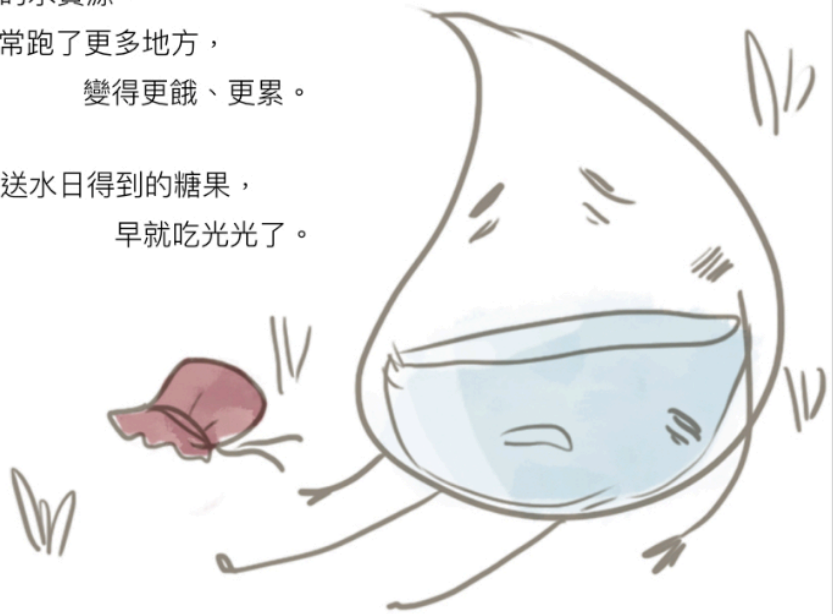
一泡下去，卻嚇得跳上來。

「這些水，怎麼這麼髒、這麼臭！
要是污染肚子裡的水就糟糕了！」



為了籌到足夠的水資源，
水寶比平常跑了更多地方，
變得更餓、更累。

上一次送水日得到的糖果，
早就吃光光了。



送水日終究還是到了。

水寶肚子裝著不多的水，疲乏地走向蘿蔔田。



「園長，請聽我解釋，

蘿蔔園、貓咪工廠和老鼠村都需要用水，
但我收集到的水只有一點點，無法給您七桶水。

這段時間，蘿蔔園可以用少一點水嗎？」

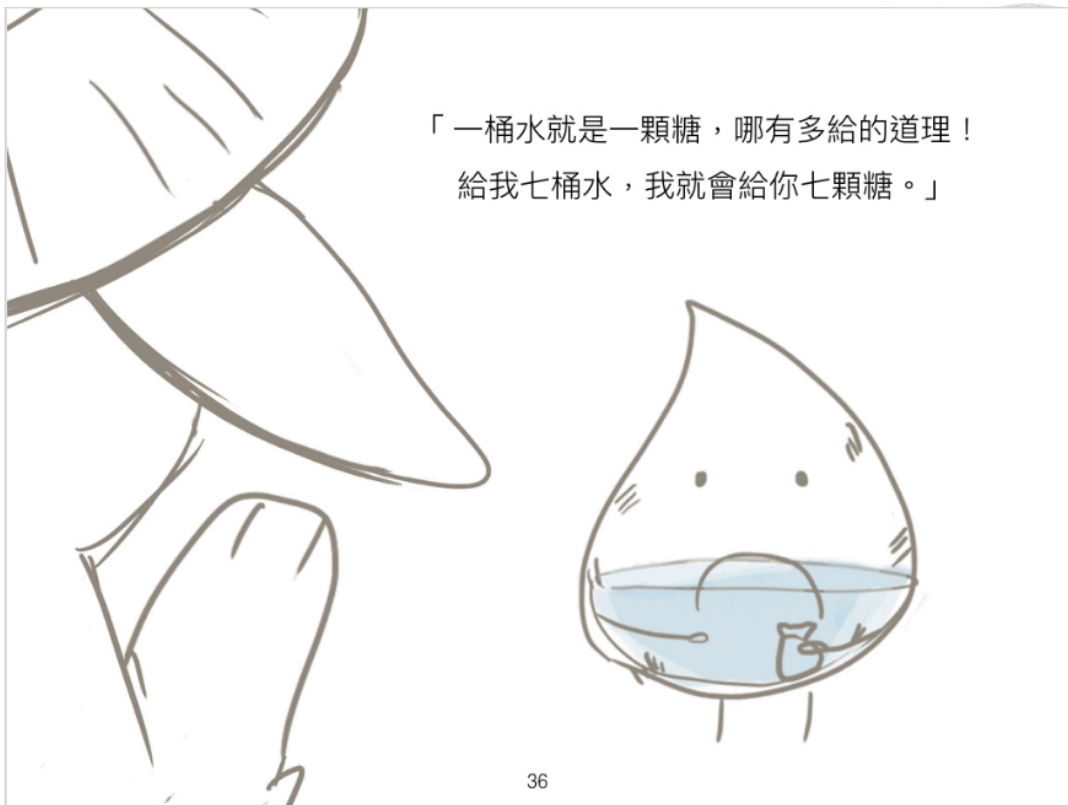


「沒有七桶水就
不夠澆灌我的田！
要嘛說服貓咪工廠少接一點單，
或叫老鼠村不要整天泡澡，
不要影響我們的糧食！」



「那麼，能不能給我一些糖果呢？
我為了找水，費了好多體力，
現在好餓、好累，
等我有力氣後，
說不定就能找到更多水……」

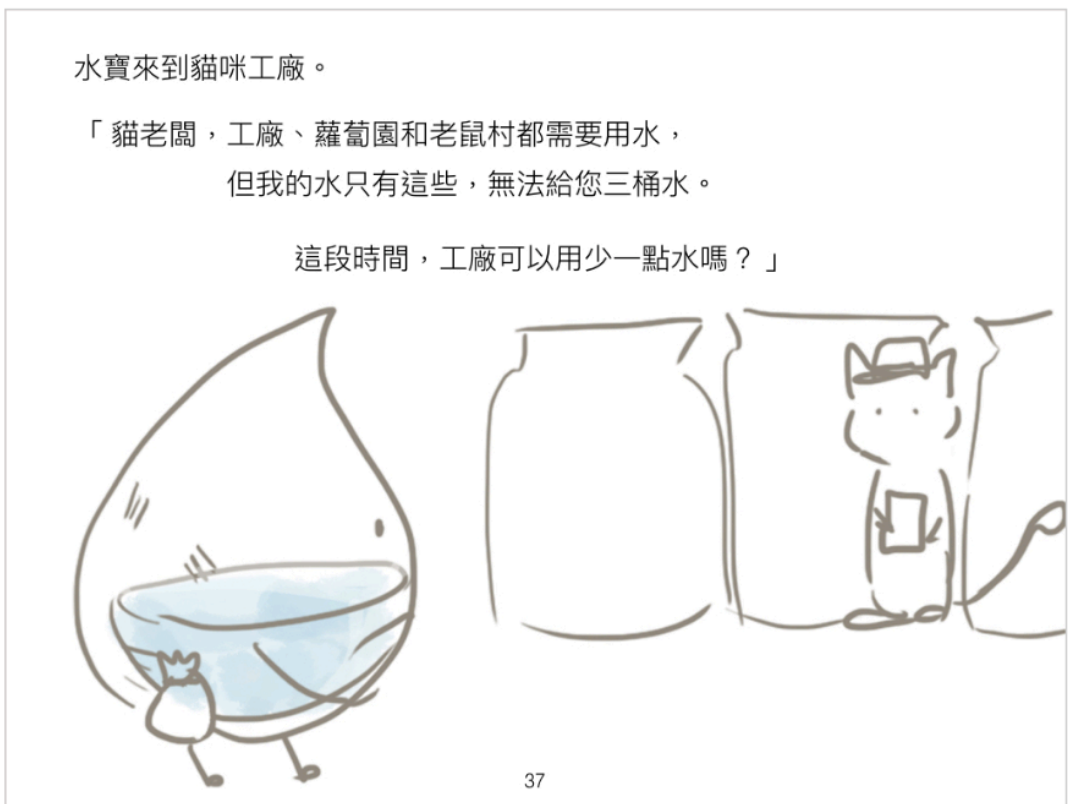
「一桶水就是一顆糖，哪有多給的道理！
給我七桶水，我就會給你七顆糖。」

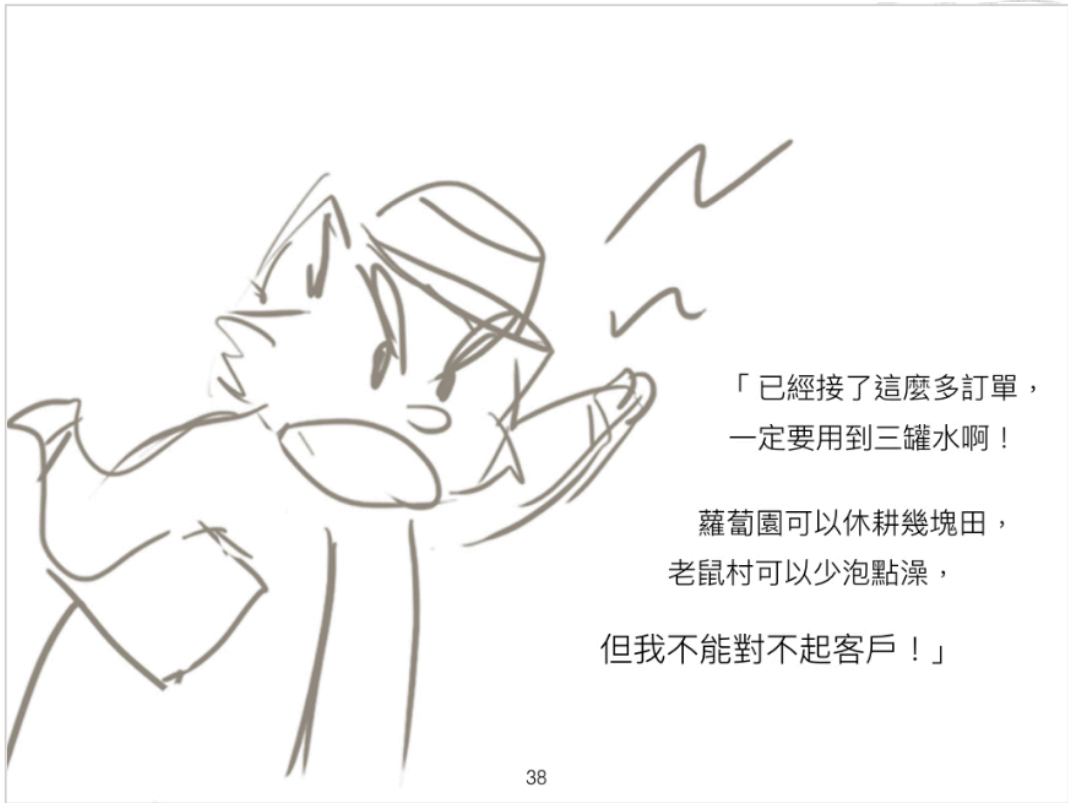


水寶來到貓咪工廠。

「貓老闆，工廠、蘿蔔園和老鼠村都需要用水，
但我的水只有這些，無法給您三桶水。」

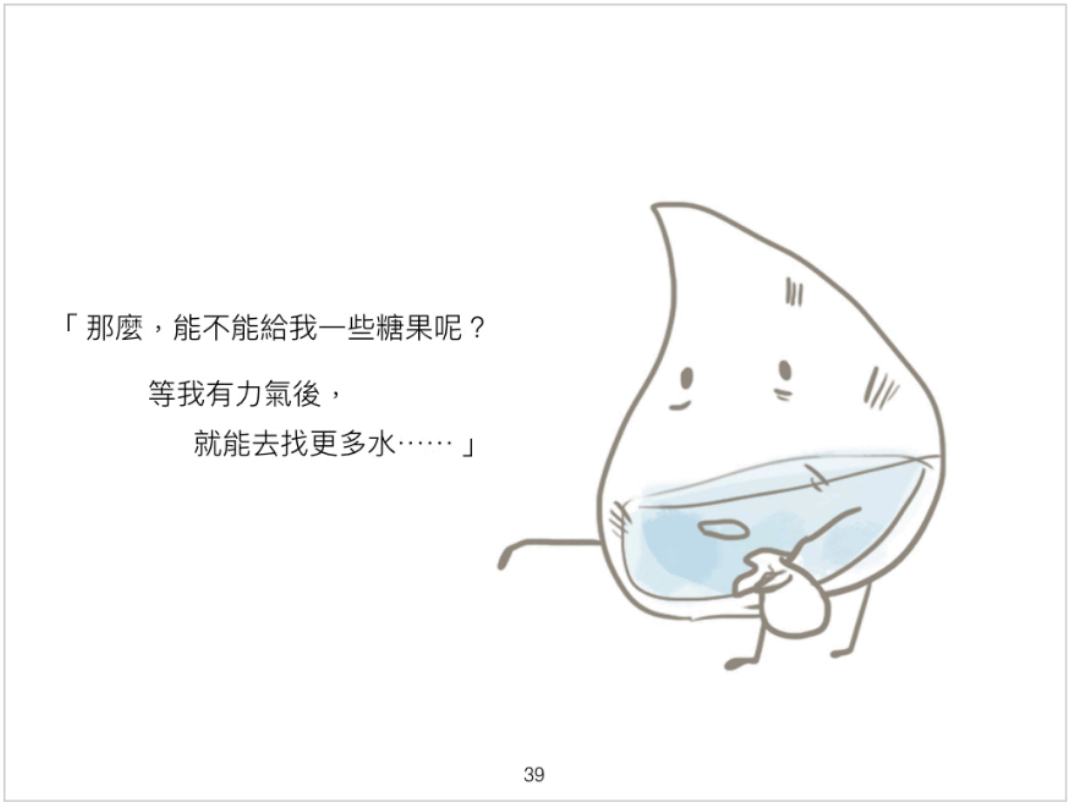
這段時間，工廠可以用少一點水嗎？」





「已經接了這麼多訂單，
一定要用到三罐水啊！」

蘿蔔園可以休耕幾塊田，
老鼠村可以少泡點澡，
但我不能對不起客戶！」



「那麼，能不能給我一些糖果呢？
等我有力氣後，
就能去找更多水……」

「一罐水給一顆糖，哪有多給的道理！
給我三罐水，我就給你三顆糖。」



水寶到了老鼠村，請求正在泡澡的老鼠頭目。

「頭目，老鼠村恐怕不能繼續這樣泡澡了……
貓咪工廠和蘿蔔園，都需要水，我無法給您兩桶水。」

老鼠村，可以用少一點水嗎？」



「老鼠村不天天泡澡就活不下去啊！

蘿蔔少種一點，
工廠少接一點訂單，
就可以省下很多水了。

為什麼要壓縮到我們的泡澡水！」

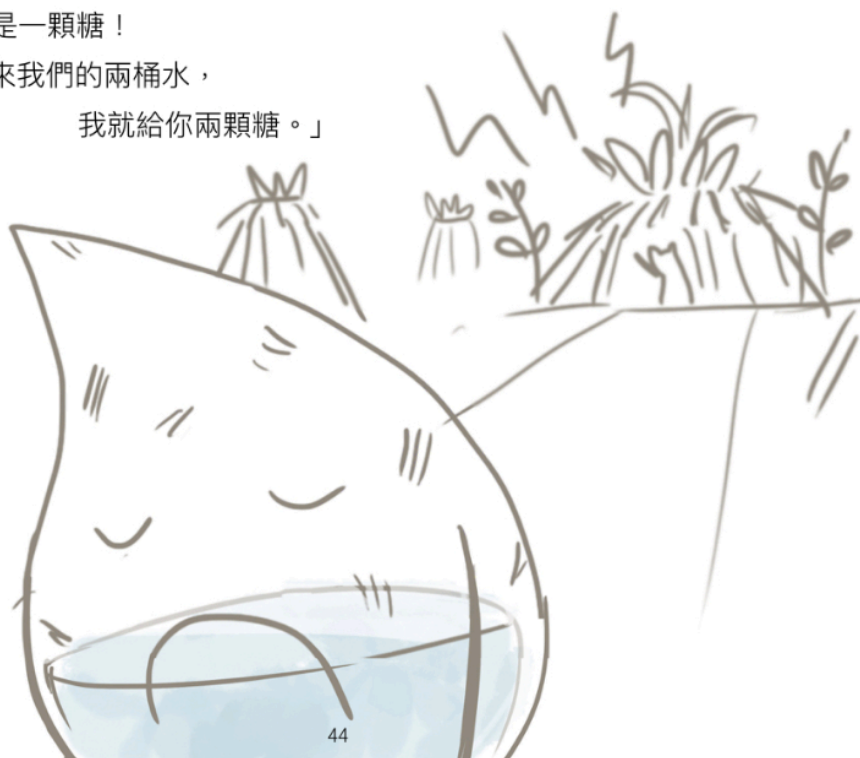


水寶抱著最後一絲希望問：

「能不能多給我一些糖果呢？

等我有力氣後，
就能再去找更多水……」

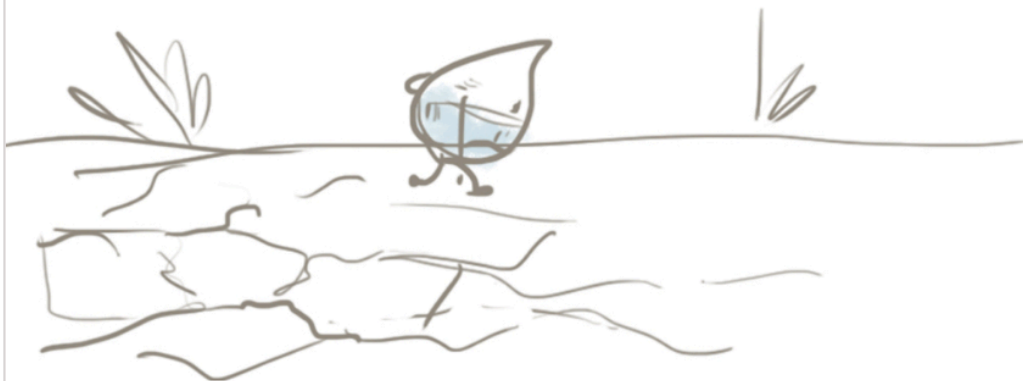
「一桶水就是一顆糖！
等你帶來我們的兩桶水，
我就給你兩顆糖。」



44

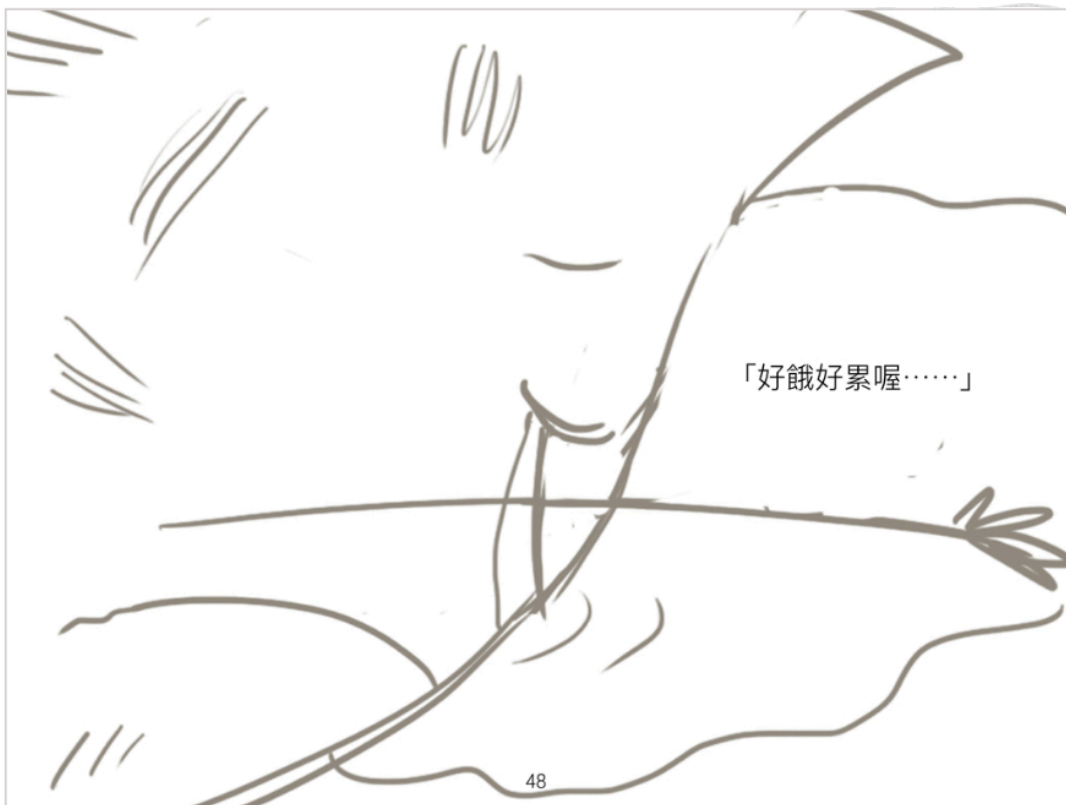
「無法說服大家用少一點水，大家似乎都有著合理的理由。」

「如果繼續找不到水，我永遠無法滿足大家。」



45





此時，兔子蘿蔔園的灌溉用水，就快要用完了。

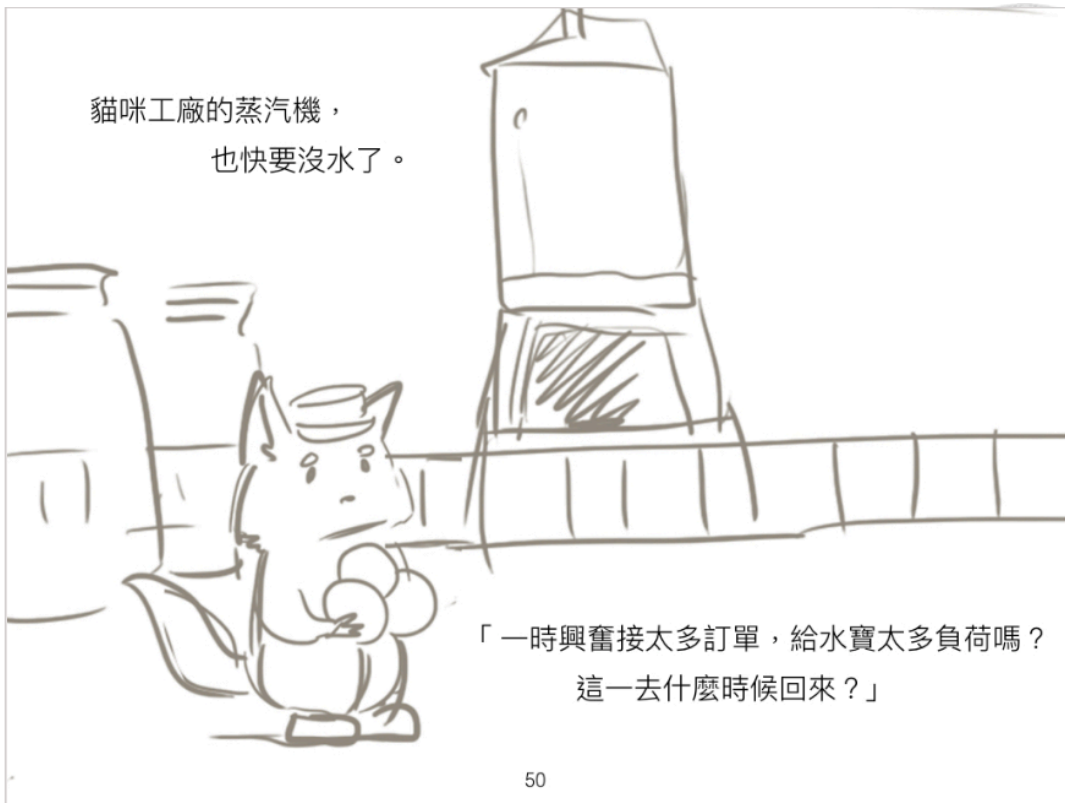
「其實，五桶水也是可以加減種一些……」

一時生氣把水竇趕回去，這下子不知道什麼時候回來？」





貓咪工廠的蒸汽機，
也快要沒水了。



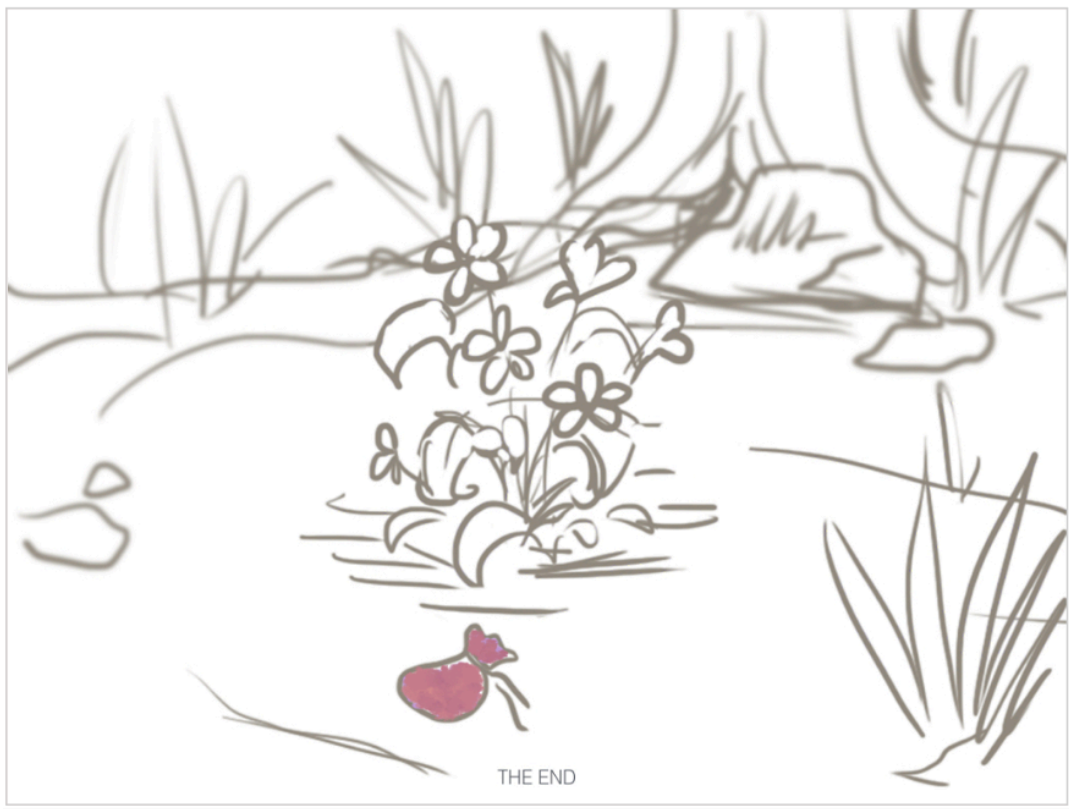
「一時興奮接太多訂單，給水賣太多負荷嗎？
這一去什麼時候回來？」



而老鼠村的泡澡水也……

「水賣以前總是有求必應，這一去什麼時候回來？」

「水寶這一去什麼時候回來？」



THE END

Appendix 2

Sheet of *WaterBob*



Score

水寶的故事

張沅真

♩ = 60

Flute

Clarinet in B \flat

Bassoon

Timpani

Vibraphone

Percussion

Guitar

Violin I

Violin II

Viola

Cello

Electric Piano

©

水寶的故事



2
7

Fl.

Vln. I

E. Pno.

13

Fl.

Vln. I

20

Fl.

B \flat Cl.

Vln. I

26

Fl.

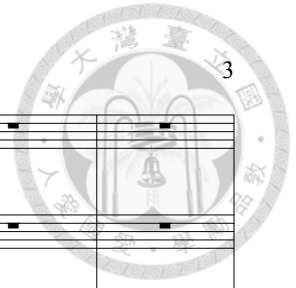
B \flat Cl.

Vln. I

26

The image shows a musical score for the piece "Water Treasure's Story" (水寶的故事). The score is arranged in systems for various instruments. The first system includes Flute (Fl.), Violin I (Vln. I), and Electric Piano (E. Pno.). The second system includes Flute (Fl.) and Violin I (Vln. I). The third system includes Flute (Fl.), B-flat Clarinet (B \flat Cl.), and Violin I (Vln. I). The fourth system includes Flute (Fl.), B-flat Clarinet (B \flat Cl.), and Violin I (Vln. I). The score is written in 4/4 time and features a key signature of one flat (B-flat major or D minor). The piece begins at measure 2 and ends at measure 26. The notation includes various musical symbols such as notes, rests, and dynamic markings.

水寶的故事



32

Fl.

B♭ Cl.

Bsn.

Vln. I

38

Bsn.

Vib.

38

Gtr.

Vc.

45

Vib.

45

Gtr.

Vc.

45

E. Pno.

Detailed description: This is a musical score for the piece '水寶的故事'. It consists of ten staves for various instruments. The first system includes Flute (Fl.), B♭ Clarinet (B♭ Cl.), Bassoon (Bsn.), and Violin I (Vln. I), starting at measure 32. The second system includes Bassoon (Bsn.), Vibraphone (Vib.), and Guitar (Gtr.), starting at measure 38. The third system includes Vibraphone (Vib.), Guitar (Gtr.), and Violoncello (Vc.), starting at measure 45. The fourth system includes Electric Piano (E. Pno.), starting at measure 45. The score is written in G major (one sharp) and 4/4 time. The key signature is indicated by a single sharp (F#) on the treble clef. The piece concludes with a final chord in the electric piano part.

水寶的故事




6

111
Gtr. 

118
Gtr. 

124
Bsn. 

124
Gtr. 

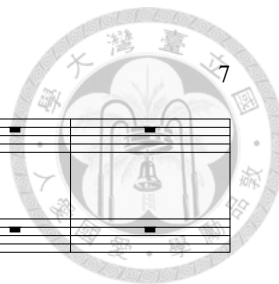
131
Fl. 
B♭ Cl. 
Bsn. 

138
Fl. 
B♭ Cl. 
Vla. 

144
Fl. 
B♭ Cl. 
Vla. 



水寶的故事



149

Fl.

B \flat Cl.

Vla.

E. Pno.

149

E. Pno.

155

E. Pno.

Detailed description: This block contains musical notation for five instruments: Flute (Fl.), B-flat Clarinet (B \flat Cl.), Viola (Vla.), and two systems of Electric Piano (E. Pno.). The first system (measures 149-154) shows the Flute and B-flat Clarinet with whole rests, the Viola with a rhythmic pattern of eighth notes and chords, and the Electric Piano with a simple accompaniment. The second system (measures 155-160) shows the Electric Piano with a more complex melodic line in the right hand and a steady accompaniment in the left hand.