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碩士論文

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音樂介入天文學課程對 11 年級學生學習成效之影響

The Impact of Incorporating Music into Astronomy Course on 11th Grade Students' Learning Outcomes

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摘要

從許多研究中可發現音樂可促進智能表現，自從 Rauscher, Shaw, & Ky (1993)他們的研究之後，「音樂能夠讓人變聰明！」變成眾所皆知的標語了。因此，我想知道音樂介入天文學課程中是否也能夠促進學生的學習表現。我的樣本為 380 位十一年級的高中生(288 位男生，92 位女生)，他們大約 16 至 17 歲，全部都來自於同一所高中。

藉由天文學態度問卷(AAQ)、天文學測驗(AKT)、音樂喜好問卷(MPS)、學生背景調查問卷(SBS)，來探討是否音樂能夠給學生帶來正面的影響。如果可以的話，什麼種類的音樂會比較好？因此，根據 MPS，我把學生分成三組(古典音樂組、流行音樂組、控制組)，藉此來探討是否有音樂介入，學生的表現會比較好，且是否學生最喜歡的音樂組(流行音樂組)，會表現最好。結果是流行音樂組的表現，並沒有顯著與控制組有差別，而古典音樂組似乎對學生的表現造成負向影響。

關鍵字：莫札特效應、音樂與認知、音樂喜好

Abstract

Many researches had found that music can promote intellectual performance. Since the research of Rauscher, Shaw, & Ky (1993), "Music makes you smarter!" became a well-known slogan. So what I would like to know is whether incorporating music into astronomy course can improve students' performance as well. My samples are 380 high school students (288 male, 92 female), 11^{th} grade, 16-17 years old, all from the same high school.

By using (a) Attitude towards Astronomy Questionnaire (AAQ), (b) Astronomy Knowledge Test (AKT), (c) Music Preference Survey (MPS), (d) Students' Background Survey (SBS) to find out if music play a positive role in students' learning outcome. And if it can, what music is better. So by using MPS, I divided the students into 3 groups (classical, pop, no music), to see whether music groups have better performance, and whether pop music (students prefer) can give the best consequence. The result was that the pop music group did not show a significant difference compared to the control group, and the classical music group, music listening seems to give a counter effect.

Keywords: Mozart effect, music and cognition, music preference

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Introduction

The idea that "music makes you smarter" has drawn considerable attention to scholars, the media and the public since the research by *Rauscher, Shaw, & Ky (1993)*. They claimed that participants, who listened to music composed by Mozart, have superior spatial abilities, compared to those who sat in silence or listened to instructions, this is so called the "Mozart effect". If there really is a Mozart effect, that is to say, if there is a simple convenient way to become smarter, it would be worth a try during intellectual learning. For instances, in Schellenberg (2005), he claimed that intellectual benefits of exposure to music would be noteworthy if

(a) they can extend to nonmusical abilities,
(b) they are systematic and reliable, and
(c) they are more likely to result from hearing or playing music than from other activities.

In many researches, music listening and music lessons have been claimed to confer these intellectual advantages. For researches on music listening, they found that there is short term enhancement on a variety of cognitive tests, and this advantage was said to attribute to arousal and mood. And for researches on music lessons, especially in childhood, there are general and long-lasting intellectual benefits, which cannot be attributed to family income and parents' education.

Many researches had provide evidences that passive listening to music composed by Mozart produces temporary increases in spatial abilities (Hetland, 2000b; Rauscher, Shaw, & Ky, 1993). So it seems that music listening can indeed enhanced performance on cognitive ability. But is there only a Mozart effect? Some researches replicated the Mozart effect, and not only did they find "Mozart effect", but also other effects as well. That is to say, listening to music composed by Mozart does not necessary have unique or special consequences for cognitive abilities. Therefore, I would like to know

(a) which types of music can have influence on academic performances, and

(b) if music listening can also impact students' performance on specific, nonmusical subjects, Astronomy in my case.

This is my pilot study of incorporating music into Astronomy course on 11th grade students. There are about 400 students (9 classes) as our sample, and they are divided into 3 groups, 3 classes per group: one control group (with no music incorporated), one "classical music" group, and one "pop music" group.

My assumption is that the two music groups should have better learning outcomes than the control group. And whether classical music (used in past researches) or pop music (most students' preference) has better learning outcomes is another question I want to find out in this study.

Background and Context

Mozart Effect

The term “Mozart effect” was first described by Tomatis (1991), in his book *Pourquoi Mozart? (Why Mozart?)*. He used the music of Mozart on medical purpose, such as ear training for those who had damaged their hearing, or brain healing and development.

Mozart effect was then used in education by Rauscher, Shaw, & Ky (1993). They reported participants who listened to *Mozart's Sonata for Two Pianos in D Major K. 448* have temporal superior spatial abilities, compared to those who listened to relaxation instructions or sat in silence. Thirty-six college students participated in all three conditions, and during each condition, the student’s spatial abilities were immediately tested after ten minutes listening or silence. The testing material was the Stanford-Binet Intelligence Scale: 4th Edition (Thorndike, Hagen, & Sattler, 1986), which was the first intelligence test that measures intelligence and cognitive abilities in children and adults. The IQ scores for the three conditions were 119 for listening to Mozart’s sonata, 111 for listening to relaxation instructions, and 110 for silence. The pulse rate of each participant was measured before and after each condition, and no interactions or effects were found, so it is said that the effect of arousal can be excluded. Thus, the Mozart condition was said to have an effect on spatial tasks. But the effect was said to be temporal, which only last for ten to fifteen minutes after listening to the music, therefore, Rauscher et al. reported that the Mozart effect is limited to temporal spatial tasks only.

Other Effects

Other researchers replicated the Mozart effect, and some also found a Mozart effect. They claimed that participants who listened to Mozart's music, compared with those sitting in silence, have relatively positive moods and optimal arousal, thus lead to their higher performance on spatial tasks (Thompson, Schellenberg, & Husain, 2001; Husain, Thompson, & Schellenberg, 2002).

Thompson, Schellenberg, & Husain (2001) claimed that listening to music composed by Mozart influences the listeners' mood and arousal, which can affect their performance on spatial tasks. The participants were divided into three groups: One was listening to fast-tempo music by Mozart in major (happy sounding music), the second was listening to slow-tempo music by Albinoni in minor (sad sounding music), and the third was sitting in silence. The spatial abilities of these participants were measured after listening to music, or sitting in silence for ten minutes. The result was that there was also a Mozart effect compared to participants sitting in silence. And to those who listened to Albinoni, they did not do better than those sitting in silence, that is to say, there was no "Albinoni effect".

Does this mean that only music composed by Mozart can provide intellectual benefits? That is to say, is there only "Mozart effect"? In Husain, Thompson, & Schellenberg (2002), Mozart's music was played in four different versions: Fast-tempo in major, slow-tempo in major, fast-tempo in minor, and slow-tempo in minor. The participants in each music group completed a spatial task after listening to the music. And the performance was better for those who listened to fast-tempo versions, and better in major than in minor. Thus, Husain et al. (2002) claimed that music with faster tempo and happier sounding, may give listeners more positive moods and optimal arousal, and lead to their better performance on spatial tasks. This may be called an “up-beat music effect”.

Nantais & Schellenberg (1999) replicated the Mozart effect, and compared to those sitting in silence. Not only did they find a “Mozart effect”, they also found a ‘‘Schubert effect’’. And when listening to Mozart was compared to listening to a narrated story, they found that the performance was associated with the participants’ preferences. Listeners who preferred Mozart, performed better after listening to Mozart, while listeners who preferred the story showed the opposite, which may be called a ‘‘preference effect’’.

Later in Schellenberg & Hallam (2005), they claimed that there was also a “pop music effect” for 10 and 11 years old children, who performed better on a spatial test after listening to pop music, compared to music composed by Mozart or a scientific discussion.

And in another study among 5 years old children (Schellenberg et al., 2005), the creativity of the children’s drawings were judged. The children were randomly placed in different music group, and they drew with crayons after listening to Mozart, Albinoni, or familiar children’s songs. The drawings of children exposed to (either by listening or singing) familiar songs, were judged to be more creative, which was called a ‘‘children’s play song effect’’.

In sum, music listening seems to have a considerable relation with enhanced performance on some cognitive abilities, which is mediated by arousal and mood. And listening to music composed by Mozart does not necessary have the only special effect. Rather, music which are up-beat, and which listeners prefer or are familiar with, can give them optimal arousal and moods, which can lead to their better performance, at least for a brief ten to fifteen minutes.

Music Preference

From above, we can conclude that music people prefer lead to better cognitive performance. But why do people prefer certain types of music? Some researchers said that certain types of music can reveal important information about one's personality (Cattell & Anderson, 1953). Some said that certain types of music may lead to different arousal state on different types of people, which one may or may not enjoy experiencing (Gowensmith & Bloom, 1997; Namara & Ballard, 1999). And some said that music can also be a symbol that shows one's social identity (North & Hargreaves, 1999). Rentfrow & Gosling (2003) thus developed a theory to explain people's music preference.

Rentfrow & Gosling (2003) did a series of studies, from the importance of music to the relation between music and cognitive ability, to establish their theory on music preference. In one of these studies, Rentfrow & Gosling (2003) developed a 7-point Likert-type scale, called the Short Test of Music Preference (STOMP) to identify the basic dimensions in fourteen music genres, and the result was that these music genres can be classified into four dimensions, which are *Reflective and Complex (e.g. classical music)*, *Intense and Rebellious (e.g. heavy metal music)*, *Upbeat and Conventional (e.g. pop music)*, *Energetic and*

Rhythmic (e.g. electronica or dance music).

These four music dimensions are said to give people different feelings. For example *Reflective and Complex* music give a feeling of cleverness, produce both positive and negative affect, and make people more relaxed. *Intense and Rebellious* music tend to produce more negative affect, and make people feel more enthusiastic and energetic. *Upbeat and Conventional* music provide simplicity to people, produce positive affect, and also make people feel relaxed. *Energetic and Rhythmic* music make people rhythmic.

Cognition and Music

Traditionally, science is thought to be a field of logical reasoning, and music a field of creativity. But to discover new approaches to problems, scientists need creativity and imagination; and to understand a piece of music, musicians need logical reasoning as well. So it seems natural that these two different fields should influence each other.

And the reason that listening to preferable or familiar music improves the performance of certain cognitive abilities is said to be the happiness feeling music brings. But why is this happiness a media to our cognition? From studies of emotions, it is said that people's positive emotions can lead to a more analytical thought, while negative emotions will lead to the basic survival thinking (Ekman, 1999), thus the happiness may lead to more analytical thinking.

From the viewpoint of brain development, Levitin (2006) described that music can reach every level of neural activity that stimulates the brain, so it should be a positive influence on the performance of science.

For example, language and spatial centers are activated when trying to comprehend a piece of music; the hippocampus (memory system) must be activated, so that people know what comes next in the music; the brain stem (controls heartbeat and respiration) is also involved when controlling the rhythm in music. Loui and Wessel (2009) also said that music learning activates the same brain areas as people learn language and math. Thus music should be able to inspire scientific thought.

There are still more findings in brain development, Gaser and Schlaug (2003) found that the brain of a musician has a larger corpus callosum, the structure that connects the left and right brain. And this is important because a larger corpus callosum improves general brain function. He also found that the grey matter (neuron cell bodies) in the brain increases from musical training, which may make the brain process information more effectively.

There is also an interesting point of view that may explain why people generate positive emotions when listening to familiar music; it is because of “expectations” (Levitin, 2006). Levitin (2006) said that when people listen to music they know, they are able to predict the musical structure before the music actually plays to the passage. Therefore, emotions form when the music follows or contradicts one’s expectation. And as long as it is within one’s comprehension, music can produce the most thrilling emotions when it challenges people’s expectations.

People are always generating expectations when listening to music, and the areas in the brain get activated no matter listening to what music, even for people who had no musical training (Loui et al., 2009). Loui et al. (2009) said that even when people listen to novel music, within an hour, the brain will start to act like it does for familiar music. This shows that the brain is rapidly forming expectations to the novel music. Thus, just simply listening to music is enough to stimulate all levels of the brain (Young, 2010).

Cognitive Transfer of Music

If simple listening to music, which doesn't take much time and only produce a ten to fifteen minutes short effect, can activate the brain, then longer musical training should have a longer impact on cognitive abilities. The intellectual benefits of exposure to music would be noteworthy if they extend to nonmusical abilities; this is called the "transfer effect" (Schellenberg, 2005). The transfer effect can be a near transfer or a far transfer. A near transfer occurs between highly similar domains, such as music lessons to speeches (Thompson, Schellenberg, & Husain, 2004). And far transfer occurs between domains that have less in common, like music lessons to reasoning or critical thinking (Barnett and Ceci, 2002).

This transfer effect is said to be unique to children who take music lessons for a certain period of time, because their experiences are different than other children (Barnett & Ceci, 2002). Those experiences may include focused attention when learning music, daily practice, reading musical notation, memorization of the music, learning musical structures, mastering the technical skills, and governing the emotion of the music etc… These experiences are said to have a positive impact on cognition, particularly during the childhood years, when brain development is highly plastic and sensitive to environmental influence

(Huttenlocher, 2002).

Some researches are done to find out the relationship between music lesson and intellectual abilities, and they showed that music lessons do seem to have positive associations with intellectual abilities, such as verbal memory (Ho, Cheung, & Chan, 2003), spatial ability (Hetland, 2000a), reading ability (Hurwitz, Wolff, Bortnick, & Kokas, 1975), selective attention (Hurwitz et al., 1975), and even mathematics achievement (Cheek & Smith, 1999).

Of course the duration of music training time should be associated with one's abilities. For example, Schellenberg, (2005) did a research on years of playing music and the association with IQ, and found that they are positively related. The IQ scores are higher for children with longer periods of training, and the results were long lasting, which is not attributable to obvious variables like parents' status or income. And this effect is distinct from other nonmusical out-of-school activities, such as drawing, drama, or speech.

Impact of Music

But why is it that music seems to have these effects? And why not other equivalent abilities, like drawing, drama or speech lessons etc… Rentfrow & Gosling (2003) did a study on people's beliefs about the importance of various activities, and music along with hobbies turned out to be the most important activities in everyday life. They also found that people believed that music and hobbies can give others information about one's personality. They also investigated the situations that people tend to listen to music, and found that people listen to music in nearly every situation, except from sleeping. Thus, music is important to people; it is an everyday lifetime activity.

Moreno et al., (2011) compared the performance of verbal intelligence between students in music group and visual art group, and they found out that only children in the music group exhibited an enhancement. Schellenberg (2004) also did a general IQ test between music and drama group, and found that only children in the music group had an increase in IQ.

The reasons that music has the unique effect may be it is a school-like subject; nearly in every school year children have music lessons at school. Another reason is that most children enjoy music lessons. And also, during the music lessons, multiple skills are trained, such as attention, concentration, memorization, reading music, fine-motor skills, expressing emotions etc… either with or without intention. Thus, Schellenberg (2005) claimed that the skills children learned in these music lessons may more or less transfer to other nonmusical areas, which may lead to their improvement in intellectual abilities. And last, if one is to learn a new knowledge, the language used in that field is quite important. For example like learning science, children need to understand the vocabulary in science first. And acquiring musical knowledge is somehow similar to acquiring another language, in order to understand music (Craik & Bialystok, 2005).

Research Questions

So can music really make you smarter? From what I read above, the answer is more or less a “yes”. Music listening and music lessons can lead to short-term and long-term cognitive benefits, at least in a kind of assistant way. I am not saying that with only music, one can be smarter without a lot of effort. I am sure that working hard still plays the most important role in learning anything, but music listening or learning may give the bonus credit. So with the help of music, one may do better in nonmusical areas.

From the past researches, music seems to have considerable influence on a variety of cognitive ability. Therefore, I would like to know if music listening can also improve students’ performance on specific, nonmusical subjects, such as Astronomy. One reason that I chose the subject Astronomy is because this is what I teach, and another is that, from my teaching experience, students need considerable spatial abilities in order to learn Astronomy well.

In order to gain the best relation between music and Astronomy performance, music lesson should be used as my method. But considering the teaching time limits, I chose music listening instead of music lessons. And from what *Rauscher, Shaw, & Ky (1993)* said, they reported that participants who listened to music have superior spatial abilities, compared to those who sat in silence or listened to instructions. Also, comparing to other activities, music listening is just a convenient, simple and everyday activity, that anyone may be involved in, whether purposefully (listening to the radio) or incidentally (background music), and only in some cases involve music lessons and performing (*Schellenberg, 2005*). So I suppose that if my students' spatial abilities can be enhanced by music listening, then their performance on Astronomy should be better.

Research Design

Site and Sample

There are 380 high school students (288 male, 92 female; 9 classes), 11th grade (16-17 years old), as my samples. They are all from the same high school, which is a one of the top high schools in Taiwan, regarding to the high school entrance examination score. These students have already been selected by their interest in science courses, so the samples here have considerable similarities.

There were two teachers who taught this course, one female who taught 4 of the 9 classes, and one male who taught the other 5 classes; both of them have the same teaching experience.

Measures and Data Analyses

Attitude towards Astronomy questionnaire (AAQ). Attitude was measured because attitude can play a considerable role in learning a subject, thus Attitude towards Astronomy Questionnaire (AAQ) was made into a 5-point Likert scale. The questionnaire can be seen in appendix 1.

Astronomy knowledge test (AKT). The Astronomy Knowledge Test (AKT) is to see the outcome of performance in astronomy before and after the course, and to see whether there is a difference in music group and control group. The questions are the same in both pre and posttest, only the order of the questions are different. The content of the test is shown as appendix 2.

Music preference survey (MPS). Last of all, is the Music Preference Survey (MPS), which I use to choose the music I should play in class for 5 minutes before each lesson begin, in order to help the students gain the most of their learning outcomes. From previous report, it is said that listening to music composed by Mozart does not necessary have unique or special consequences for higher performance, as long as it is age-appropriate music, music that these students prefer or familiar with, then it may improve listeners' arousal level and mood, and lead to better performance. Thus, I chose 8 different types of music (classical, pop, rock, rap, jazz, folk, soundtracks, and religious music) to find out what kind of music students prefer, and made them into a 5-point Likert scale. The reason that I chose these 8 categories is based upon a study in music preference *(Rentfrow & Gosling, 2003*), and also on the music that Taiwanese students are more familiar with. The preference survey is shown as appendix 3.

Students' background survey (SBS). The Students' Background Survey (SBS) is to see whether our sample is familiar with music, like whether their parents are in fact music professionals, or whether the students can play musical instruments themselves, or whether they have a habit of going to concerts once in a while etc. These are some variables that may influence our results, which I may not be able to control in class. The background survey is shown as appendix 4.

Procedures

First is the preparation stage, which I developed some measurements for my study. The measurements are (a) Attitude towards Astronomy

Questionnaire (AAQ), (b) Astronomy Knowledge Test (AKT), (c) Music Preference Survey (MPS), (d) Students' Background Survey (SBS).

Next is the introduction stage, which I explained the purpose of my study to my students, and give them the measurements listed above. The knowledge test here was the pretest, and the main purpose here was to find out what music these students like.

The third stage was choosing the appropriate music according to students' music preference survey and the lesson topics. By asking the students to how much extent do they like music, they need to score a point from 1~5. I also asked the students to how much extent do they like each type of music, and they also need to score a point from 1~5 in each type of music as well, so I could see what types of music were more preferable to the students.

And the result for music preference in general, was that most students like to listen to music; they scored an average of 4.4 out of 5, as shown in Table 1. And for the preference of each type of music, most students like pop music and soundtracks the most, which students scored an average of 4 point. As for classical, rock and jazz music, I assumed that students like them moderately, because they scored an average of 3.5 point for those types of music. And the music types students like the least were rap music, folk songs and religious music, as the students scored 3 point and below for them. According to the statement "music which listeners prefer or are familiar with, can led to better performance", rap music, folk songs and religious music were not the music I need to consider choosing.

Table 1. Music preference and preference for different types of music in each class.

Classes	*Music Preference*	*Classical*	*Pop*	*Rock*	*Rap*	*Jazz*	*Folk*	*Sound tracks*	*Religious*
A	4.4	3.5	4.3	3.6	3.0	3.3	3.1	4.0	2.7
B	4.6	3.8	4.1	3.0	2.4	3.4	3.1	4.2	2.6
C	4.5	3.6	4.1	3.4	3.0	3.5	3.1	3.7	2.5
D	4.4	3.6	4.2	3.6	3.0	3.6	3.0	3.8	2.4
E	4.5	3.5	4.4	3.9	3.4	3.8	3.0	3.9	2.3
F	4.4	3.4	4.1	4.4	3.0	3.6	3.0	4.0	2.3
G	4.2	3.6	4.2	3.6	3.2	3.5	3.2	4.0	2.5
H	4.2	3.8	3.9	3.3	3.0	3.4	3.1	3.8	2.8
I	4.0	3.1	3.9	3.5	2.9	3.2	2.8	3.6	2.2
Average	4.4	3.5	4.1	3.6	3.0	3.5	3.0	3.9	2.5

In Rentfrow & Gosling (2003), pop music and soundtracks are said to be somehow the same, because movie soundtracks are often as popular as pop music. And according to the four dimensions which Rentfrow & Gosling (2003) presented, pop music and soundtracks are in the same dimensions, which is "*Upbeat and Conventional*". Therefore I chose pop music as one of my experimental group, which is called the "pop music group".

As for classical, rock and jazz music, Rentfrow & Gosling (2003) had put classical and jazz into the same dimension, *Reflective and Complex*, which give people a feeling of cleverness, produce both positive and negative affect, and make people more relaxed. Rock music was said to belong to *Intense and Rebellious* dimension, which is said that these kind of music tend to produce more negative affect, and make people feel more enthusiastic and energetic. I would want my students to be more reflective of what they had learned, so rock music was out of the question. And because I am more familiar with classical music than jazz music, I chose classical music as my other experimental group, which is called the “classical music group”.

Originally, I asked the students, “If your teacher is going to play music before each lesson, which type of music do you think can help you learn the most?” And the students were to choose 1 from the 8 types of music to answer this question. I was to use this information to determine the music we want to play, but the answers to this question were highly related to the students’ music preference, so I simply use the preference data to decide.

The fourth stage, I randomly divided the students into 3 groups, 3 classes per group: one classical music group (class: A, E, H), regarding that it is students’ neutral preference; and one pop music group (class: B, C, F), which is the music students prefer the most; one control group (class: D, G, I), which no music was incorporated.

The music I chose for each music group were somewhat related to the lessons I planned, which were related as in titles or in the lyrics of the songs. For example if the lesson was about the moon, or the lunar phase, then the classical music group would be listening to “*Clair de Lune”* by *Debussy*, and the pop music group would be “*Innocent”* by *Mayday*. Although the title “*Innocent*” doesn’t seem related to the moon at all, but the lyrics had said something about the motion of our sun, moon and earth, which then is related to the concept of lunar phase. The lesson scheduled and the music chosen relatively is shown in Table 2. For a more detailed lesson schedule, see appendix 5.

Table 2. The lesson scheduled and the music chosen for classical music and pop music groups relatively.

Date	*Learning Contents*	*Classical Music*	*Pop Music*
Oct. 19	Day, Month, Lunar phase	*Debussy,* Clair de Lune	*Mayday* Innocent
Oct. 26	Year, Solar calendar, Leap year	*Vivaldi,* The four seasons L' inverno	*Taylor Swift* Back to December
Nov. 2	Lunar calendar, Chinese calendar, Leap month	*Beethoven,* Symphony No. 6 in F, Op. 68, 3	*Yui* Summer Song
Nov. 9	Day and night, The four seasons	*Haydn,* le Matin (3)	*Cheer Chen* 3 p.m.

The fifth stage was a 4-week lesson. The female teacher taught classes B, C, D, E, and the male teacher taught classes A, F, G, H, I. The relation between different music groups or classes and their teachers is shown as Table 3. The music was played in the music groups for 5 minutes before each lesson started; and as for the control group, they stayed silent for 5 minutes before each lesson started. And after the lessons, the students did the knowledge test again, which was the posttest, and multiple regression was done as my data analyses method.

Table 3. The relations of different music groups, classes and their teachers.

Music groups	*Classes*	*Teachers*
	A	Male
Classical music group	E	Female
	H	Male
	B	Female
Pop music group	C	Female
	F	Male
	D	Female
Control group	G	Male
	I	Male

Findings

Simple Statistics

What really influence the students' learning outcome? Some variables were chosen to see the influence. The simple statistics of the outcome, predictor, and control variables are as shown in table 4.

ATT: The average score of all students' attitude toward Astronomy, this data came from Attitude towards Astronomy Questionnaire (AAQ), a 5-point Likert scale. A 3.4 point meant that students have moderate attitude toward Astronomy, which they may or may not think the Astronomy course is interesting or enjoyable.

PRE_KNOW: The average score of all students' Astronomy knowledge test (AKT) before the 4-week lesson. The average score of the pretest is 7.3 out of 15, which meant that students already have some background knowledge towards Astronomy, because they have got nearly half of the questions correct. This is reasonable because these students had already been through two years (grade 9-10) of Earth Science courses, which include Astronomy lessons.

POST_KNOW: The average score of all students' Astronomy knowledge test (AKT) after the 4-week lesson. The average score of the posttest is 10.8 out of 15, which meant that students did quite well after the lessons. This is reasonable because most people progress from lessons.

MALE: The percentage of male students. The percentage is 0.76 (1 for male, 0 for female), which meant that 76% of the students are boys, and 24% of the students are girls.

CG: The percentage of the students in classical music group. 0.33 meant that one third of the students are in classical music group.

PG: The percentage of the students in pop music group. 0.35 meant that one third of the students are in pop music group.

CONG: The percentage of the students in control (no music) group. 0.32 meant that one third of the students are in control group.

TEACHER: The percentage of students taught by male teacher. The percentage is 0.54 (1 for male, 0 for female), which means that 54% of the students were taught by male teacher, and 46% were taught by female teacher.

Table 4. Simple statistics of the outcome, predictor, and control variables.

Variables	*Descriptions*	*Mean*	*Std. Dev.*
ATT	Attitude towards Astronomy course.	3.4	0.5
PRE_KNOW	Astronomy knowledge pretest score.	7.3	2.2
POST_KNOW	Astronomy knowledge posttest score.	10.8	2.2
MALE	Students' gender (0: female, 1: male).	0.76	0.4
CG	Classical music group or not (0: no, 1: yes). Classes: A, E, H.	0.33	0.5
PG	Pop music group or not (0: no, 1: yes). Classes: B, C, F.	0.35	0.5
CONG	Control group or not (0: no, 1: yes). Classes: D, G, I.	0.32	0.5
TEACHER	Different teacher (0: F, 1: M).	0.54	0.5

The simple Pearson correlations of the outcome, predictor, and control variables are as shown in table 5, to see the correlations between each variables. From the correlation table, we can see that attitude towards astronomy is correlated with students' pretest ($p<.01$) and posttest ($p<.05$) scores, the music ($p<.10$ for classical music, $p<.001$ for pop music) or control ($p<.01$) groups they are in, and which teacher ($p<.05$) who taught them. The gender does not seem to correlate with the attitude, which meant that both boys and girls have more or less the same attitude towards Astronomy.

The pretest score is correlated with attitude ($p<.01$), posttest ($p<.01$), gender ($p<.05$), and teacher ($p<.001$), while the posttest score is correlated with attitude ($p<.05$), pretest ($p<.01$), classical music group ($p<.05$), and teacher ($p<.01$). The changes between pre- and posttest (before and after the lessons), was that gender no longer influence the learning outcome (posttest score), which means that no matter boys or girls, they have the same potential to gain the same learning outcome. Also, the different groups (especially the classical music group) seem to have the some influence on the outcome as well.

Table 5. Simple Pearson correlations of the outcome, predictor, and control variables

	ATT	PRE_KNOW	POST_KNOW	MALE	CG	PG	CONG	TEACHER
ATT	1.00	0.15**	0.13*	-0.01	-0.03	0.17***	-0.14**	-0.10*
PRE_KNOW	0.15**	1.00	0.15**	-0.07	-0.03	0.10~	-0.07	-0.18***
POST_KNOW	0.13*	0.15**	1.00	-0.04	-0.12*	0.06	0.05	-0.16**
MALE	-0.01	-0.07*	-0.04	1.00	-0.19***	-0.19***	0.39***	0.06
CG	-0.03~	-0.03~	-0.12*	-0.19***	1.00	-0.51***	-0.48***	0.19***
PG	0.17***	0.10~	0.06	-0.19***	-0.51***	1.00	-0.51***	-0.33***
CONG	-0.14**	-0.07	0.05	0.39***	-0.48***	-0.48***	1.00	0.14**
TEACHER	-0.10*	-0.18***	-0.16**	0.06	0.19***	0.19***	0.14**	1.00

~ p≤.10, *p≤.05, **p≤.01, ***p≤.001

Fitted Regression Model

From the table 5, a primary control is fitted to the regression model, which is the pretest score. This is reasonable because for most students, the more pre-knowledge they have, the course should easier for them to learn, thus leading to a better outcome. When considering only the pretest as the explanation to students' learning outcome, a cubic pattern can be fitted to the model, with 1.3 ($p<.05$) as PK's coefficient, -0.2 ($p<.05$) as PK^2's, 0.01 ($p<.05$) as PK^3's, and 7.7 ($p<.001$) as the intercept. Thus, the first model can be written as: $7.7 + 1.3*PK + (-0.2*PK^2) + (0.01*PK^3)$, with an R-square of 0.04.

The main purpose of this study was to see the influence of music when incorporated into the Astronomy course, so some predictors (CG, PG) were fitted to the model. Making the coefficient of PK 1.4 ($p<.05$), PK^2 -0.2 ($p<.05$), PK^3 0.01 ($p<.05$), CG -0.6 ($p<.05$), PG -0.1 ($p<.10$), and intercept 7.9 ($p<.001$). Thus, the second model can be written as: $7.9 + 1.4*PK + (-0.2*PK^2) + 0.01*PK^3 + (-0.6*CG) + (-0.1*PG)$, with an R-square of 0.05.

From before, we know that the learning outcome was also correlated with attitude and the teacher who taught them. Thus, these two control variables were also fitted to the model, ATT and TEACHER, making the coefficient of PK 1.2 ($p<.05$), PK^2 -0.2 ($p<.10$), PK^3 0.01 ($p<.05$), CG -0.6 ($p<.05$), PG -0.3, ATT 0.4 ($p<.10$), TEACHER -0.5 ($p<.05$), and intercept 7.5 ($p<.001$). Thus, the final model can be written as: $7.5 + 1.2*PK + (-0.2*PK^2) + 0.01*PK^3 + (-0.6*CG) + (-0.3*PG) + 0.4*ATT + (-0.5*TEACHER)$, with an R-square of 0.07. The three models are as shown in Table 6 below.

Table 6. Taxonomy of fitted regression models of the effect of intervention condition (classical, pop, or control) on student's learning, controlling for prior knowledge, attitude, and teacher.

	Primary Control	***+Predictors***	***+Controls (Final Model)***
Intercept	7.73*** (1.22)	7.87*** (1.22)	7.46*** (1.32)
PK	1.32* (0.57)	1.35* (0.57)	1.15* (0.57)
PK2	-0.19* (0.09)	-0.19* (0.09)	-0.17~ (0.09)
PK3	0.01* (0.004)	0.01* (0.004)	0.01* (0.004)
CG		-0.55* (0.27)	-0.55* (0.27)
PG		-0.05~ (0.27)	-0.30 (0.28)
ATT			0.38~ (0.21)
TEACHER			-0.52* (0.23)
R^2	0.0349	0.0477	0.0691

Cell entries are estimated regression coefficients (standard errors)

~ p≤.10, *p≤.05, **p≤.01, ***p≤.001

Final Model

By using the final model: 7.5 + (1.2*PK) + (-0.2*PK^2) + (0.01*PK^3) + (-0.6*CG) + (-0.3*PG) + (-0.4*ATT) + (-0.5*TEACHER), we can see the relation between students' learning outcome and their pretest score in different groups, when controlling for their attitude and teacher. Let the control variables ATT equals 3.4 (the average score of all students' attitude toward Astronomy), TEACHER equals 0.54 (the percentage of students taught by male teacher). Then for students in the classical music group, their CG is 1, while PG is 0; for students in the pop music group, their CG is 0, and PG is 1; and last, for students in the control group, both of their CG and PG are 0. The relation for each group is shown as figure 1.

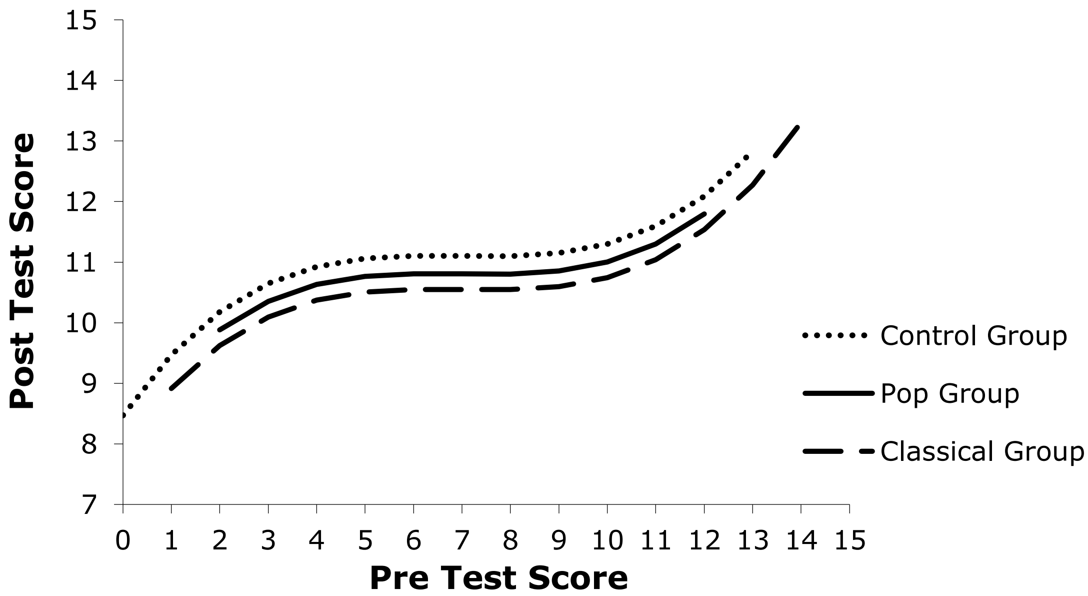

Figure 1. The relation between students' learning outcome and their pretest score in different groups, when controlling for their attitude and teacher.

From figure 1, we can see for all students, their posttest score all progressed to 8 points or more. And students with low pretest scores (below 3 points) or high pretest scores (above 11 points), their outcomes are associated with their pretest scores. That is to say, for those students, the higher the pretest scores, the higher the outcomes. But for students with medium pretest scores (3-11 points), they all come to the same posttest score (10-11 points). That is to say, the higher the pretest scores, do not necessary indicate higher outcomes. This may indicate that, for most students, they can get to a certain level after learning from lessons.

And what role does music play here? From figure 1, we can see that music groups (both classical and pop music) have slightly lower posttest scores compare to the control group. The control group did about 1 point better than the classical music group, the difference was significant ($p<.05$). Compare to the pop music group, the control group did just a little better, but the difference was not significant ($p>.05$). And comparing pop music group to classical music group, pop music group only did slightly better than the classical music group, but the difference was also not significant ($p>.05$).

Discussion

Conclusion

From the research of Rauscher et al. (1993), they found that ten minutes exposure to music composed by Mozart increases the performance of Stanford-Binet Intelligence Scale. Since then, other researchers tried to replicate and extend the Mozart effect. Some found that Mozart's music may influence the listeners' mood and arousal, and thus affect their academic performances. And some found that there are other effects as well, such as up-beat music effect (Mozart's music played in fast-tempo and major version led to better performances), Schubert effect (when Schubert's music was compared to silence, it also provided a positive effect on performances), preference effect (music participants preferred gave a more positive effect), pop music effect (music that 10 to 11 years old children prefer) and children's play song effect (music that 5 years old children prefer). Therefore, we can conclude that music which are up-beat, and which listeners prefer or are familiar with, can give them optimal arousal and moods, which can lead to their better performance.

And why do people prefer certain types of music? In Rentfrow and Gosling's (2003) series of studies, they classified music into four dimensions, which are reflective & complex (e.g. classical music), intense & rebellious (e.g. heavy metal music), upbeat & conventional (e.g. pop music), energetic & rhythmic (e.g. electronica). And because I would want my participants to be familiar with the music, to enjoy the music, to feel more relaxed, and to make them produce more positive affect, I chose the music from "reflective & complex" and "upbeat & conventional" dimensions, which are "classical music" and "pop music" respectively.

From the viewpoint of cognition, preferable music are said to bring happiness feeling, and thus lead to a more analytical thought. And from the viewpoint of brain development, there are evidences that music can stimulate the brain. As what Levitin (2006) states, people are always generating expectations when listening to music, and positive emotions form when listening to familiar music, which musical structure people are able to predict. Thus, simple listening to music is enough to stimulate the brain (Young, 2010).

And if short listening to music can give intellectual benefits, then longer exposure to music, like music lessons, are said to give transfer effects to nonmusical areas, because multiple cognitive skills can be trained during music lessons (Barneet & Ceci, 2002). And the longer the music training, the intellectual performance should be better (Schellenberg, 2005). But why use music? Why not other activities? In the study of Rentfrow and Gosling (2003), they found out that music was the most important activity in everyday life. Schellenberg (2005) claimed that because music is a school-like subject, most people should more or less have some musical experiences, and the skills learned in music lessons may transfer to nonmusical areas. What is more is that music listening is just a simple convenient activity that anyone can be easily involved in.

After analyzing the measurements, I chose the appropriate music and randomly divided the participants into three groups, classical music group, pop music group and control group. And the result was that the background knowledge (PK) the students had, played the most important role in explaining their outcome. Other variables such as attitude towards Astronomy (ATT), and which teacher who taught the students (TEACHER) influences the outcome as well. But music listening did not give a positive effect on these 11th grade participants. The pop music group did not show a significant difference compared to the control group, that is to say, when these students listened to music they prefer the most, their outcomes were no better than the control group. And as for the classical music group, music listening seems to give a counter effect. Thus, music listening did not seem to enhance students' Astronomy knowledge, especially listening to music students' do not prefer the most.

Limitations

There may be several reasons that cause the counter effect. First, the participants are from the one of the top high schools in Taiwan, that is to say, their outcome may mostly be caused by their studying ability. Second, music experiences are said to have positive impacts on cognition, particularly during the childhood years, when brain development is highly plastic and sensitive to environmental influence (Huttenlocher, 2002). But for 11th grade students, their brains should be fully developed, so the impact of music may be quite limited. Third, the music listening lasted only for a month, therefore this may be too short a time to see the effect. Fourth, before the lessons, the students were told that they were to participate in this research, thus there may be a John Henry effect, which means that the participants were aware of the research, and this may lead to higher outcomes in the control group.

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Appendix A

天文學態度量表

親愛的同學們：

　　這是一份小小的「民意調查」，想問問你對「天文學」的感受，以作為老師教學時的參考，和成績完全無關！在作答時，請根據你自己的感受，以「2B 鉛筆」在答案卡的方格中，選擇一個填滿即可。

　　敬祝

　　　　身體健康　學業猛進

※對天文學所持的態度	很不同意 A	不同意 B	普通 C	同意 D	非常同意 E
1.我對天文學很有興趣。	☐	☐	☐	☐	☐
2.上天文學課時，我的心情總是輕鬆愉快。	☐	☐	☐	☐	☐
3.和同學一起討論天文學的問題是很無聊的事。	☐	☐	☐	☐	☐
4.天文學知識對我的生活沒有什麼用處。	☐	☐	☐	☐	☐
5.上天文學課時，我時常覺得腦袋空空，無法思考。	☐	☐	☐	☐	☐
6.對天文學問題，我寧可相信別人的說法，而不喜歡自己去觀察或探討。	☐	☐	☐	☐	☐
7.我喜歡閱讀報章、雜誌中與天文學有關的文章。	☐	☐	☐	☐	☐
8.天文學課的內容既單調又乏味。	☐	☐	☐	☐	☐
9.有天文學問題時，請教老師就好，自己找資料或看書太浪費時間了。	☐	☐	☐	☐	☐
10.天文學的知識很難理解。	☐	☐	☐	☐	☐

	很不同意	不同意	普通	同意	非常同意
※對學習天文學所持的態度	A	B	C	D	E
11.我覺得上天文學課非常有趣。	□	□	□	□	□
12.我喜歡觀察生活中的現象以了解天文學，不僅僅只是看書本的描述。	□	□	□	□	□
13.天文學跟我們生活息息相關。	□	□	□	□	□
14.一想到今天有天文學課，我的心情就很愉快。	□	□	□	□	□
15.我喜歡研究與天文學有關的問題。	□	□	□	□	□
16.我不喜歡探討天文學的問題。	□	□	□	□	□
17.上天文學課，能幫助我們更了解自己和周遭的世界。	□	□	□	□	□
18.碰到有不懂的天文學問題時，我會去查資料，找出答案。	□	□	□	□	□
19.我希望能多了解天文學的各項研究。	□	□	□	□	□
20.我覺得天文學課所學的知識，對我本身並沒有什麼用處。	□	□	□	□	□

※對參與天文學活動所持的態度	A	B	C	D	E
21.做天文學戶外教學很浪費時間又沒有意義。	□	□	□	□	□
22.天文學是人類知識領域中很重要一門學問。	□	□	□	□	□
23.在圖書館，我喜歡翻閱和天文學有關的書刊或雜誌。	□	□	□	□	□
24.我覺得要自己親自觀察、分析，才能真正學到天文學知識。	□	□	□	□	□
25.我對電視上有關天文學的節目沒有興趣。	□	□	□	□	□
26.每一個人都應該學習一些天文學的知識。	□	□	□	□	□
27.我覺得天文學應以戶外教學為主。	□	□	□	□	□
28.我不喜歡參觀有關天文學的展覽。	□	□	□	□	□
29.學習天文學對改善人類生活毫無幫助。	□	□	□	□	□
30.我喜歡參與天文學活動或觀星活動。	□	□	□	□	□

Appendix B

天文學知識測驗

這部分是老師接下來到第二次段考前會上的內容...先測試看看自己的實力有多少吧！請以「2B 鉛筆」在答案卡上的方格，選擇一個最適當的選項填滿即可。請盡力做答，寫錯不要難過，重點是等我上完這部分的內容，就要會喔！

1. 現今國曆的一個月是怎麼定出來的？ (A)月球完整繞地球一周的時間 (B)月球自轉一周的時間 (C)月相從朔到下一次朔所需的時間 (D)與月相無直接關係。

2. 承上題，那農曆的一個月又是怎麼定出來的？ (A)月球完整繞地球一周的時間 (B)月球自轉一周的時間 (C)月相從朔到下一次朔所需的時間 (D)與月相無直接關係

3. 假設某人在 2011 年 4 月 10 日想要觀察北斗七星，並且希望這七顆星的位置與一個禮拜前的午夜 12 點相同，那麼他應該要幾點觀察？
(A)晚上 11:32 (B)晚上 12:00 (C)晚上 12:14 (D)晚上 12:28。

4. 承上題，會造成此結果的主要原因為下列何者？ (A)對於陽曆一天的定義，是遙遠恆星兩次通過當地子午線的時間間隔 (B)對於陽曆一天的定義，是太陽兩次通過當地子午線的時間間隔 (C)對於陽曆一天的定義，是地球完整自轉一周的時間 (D)對於陽曆一天的定義，是地球快要完成自轉一周時間。

5. 有時候在早上上學途中，抬頭可以看見月亮，此時的農曆日期可能較接近下列何者？
(A)初一 (B)初七 (C)十五 (D)二十三 日。

6. 當月食發生的時候，只要是可以觀察到此現象的人，會看到月面的某一側開始出現缺角，再慢慢看到此缺角擴大(可參考右圖)，最後才會看到月面慢慢復原。從你對月食成因的了解，判斷月食開始的時候，缺角應先出現在月面的哪一側？ (A)東 (B)西 (C)南 (D)北 側。

7. 關於現在的節氣，下列敘述何者<u>**錯誤**</u>？
(A)節氣與太陽在天球上的位置有關 (B)每個節氣出現在國曆的日期大致固定
(C)每個節氣之間的時間間隔是一樣的 (D)節氣是農曆置閏月的依據。

8. 我們的農曆生日與國曆生日，通常每年(除出生那年)都會出現在不同天，不過對大部分的人來說，在特定幾年，會有機會看到自己農曆生日與國曆生日在同一天或差一天，那麼此時比較有可能是幾歲(以國曆計算的年齡)？
(A) 24 歲 (B) 38 歲 (C) 60 歲 (D)國曆與農曆沒有相關，所以無從得知。

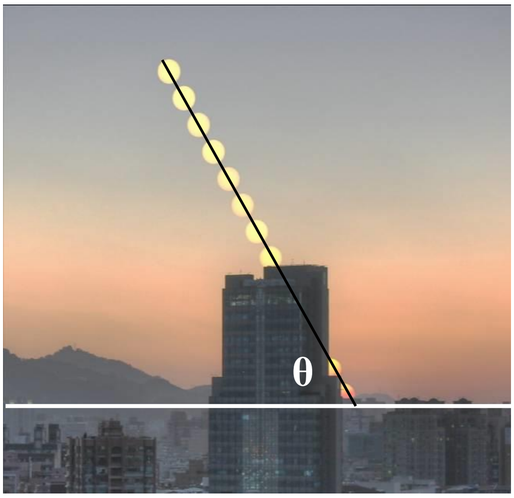
9.

10. 下列的西元年份中，何者應為閏年，也就是在二月時會有 2 月 29 日這個日期？
(A) 1900　(B) 1987　(C) 2000　(D) 2011 年。

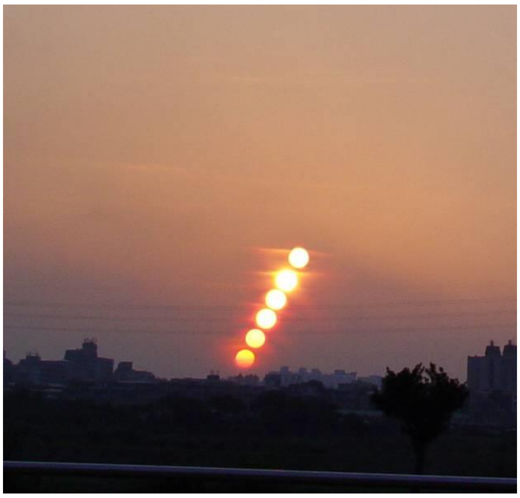
11. 現在的地球各個季節晝夜長短不同的主要原因為何？
(A)地球繞日公轉的結果　(B)太陽與地球的距離改變
(C)地球自轉的結果　(D)地球自轉軸與地球公轉軌道面並不垂直。

12. 假設地球自轉軸的傾斜角度從 23.5 度變成 35 度，而其他條件皆不變的情況之下，下列關於台灣夏至那天的晝夜變化何者敘述正確？
(A)白天長度變短，晚上長度變長　(B)白天長度變長，晚上長度變短
(C)白天長度變長，晚上長度變長　(D)白天長度變短，晚上長度變短。

※ 題組：【圖一】、【圖二】為 2010 年 12 月 31 日在兩個不同地點所拍攝到的日落軌跡圖，根據這兩張影像回答下列第 12~15 題。



【圖一】



【圖二】

13. 【圖一】與【圖二】的右側，各是什麼方位？
(A)北、南　(B)南、北　(C)南、南　(D)北、北。

14. 【圖一】比較有可能是下列哪一地點所拍攝到的影像？
(A)阿拉斯加　(B)台灣　(C)新加坡　(D)澳洲。

15. 承上題，則此處的日落軌跡與地平面的夾角(即圖中 θ 處)，應較接近下列幾度？
(A) 65 度　(B) 45 度　(C) 25 度　(D) 5 度。

16. 在【圖二】的觀察點，2011 年 9 月 23 日當天的日落軌跡，應該會出現在哪裡？
(A)與圖中日落軌跡一樣　(B)圖中日落軌跡的左側　(C)圖中日落軌跡的右側
(D)太陽落下的點與圖中一樣，但軌跡應為垂直落下。

Appendix C

音樂喜好調查

這部份是想問問你對「音樂」的喜好，以作為老師上課前選用音樂的參考。在作答時，希望你根據自己的感受，以「2B 鉛筆」在答案卡的方格中，僅選擇一個填滿，全部皆為單選題喔！

	很不喜歡 A	不喜歡 B	普通 C	喜歡 D	非常喜歡 E
1. 你對音樂的喜好程度為何？	□	□	□	□	□
2. 你對「古典音樂」的喜好程度為何？	□	□	□	□	□
3. 你對「流行音樂」的喜好程度為何？	□	□	□	□	□
4. 你對「搖滾音樂」的喜好程度為何？	□	□	□	□	□
5. 你對「饒舌歌、嘻哈」的喜好程度為何？	□	□	□	□	□
6. 你對「藍調、爵士樂」的喜好程度為何？	□	□	□	□	□
7. 你對「民族、民俗、民間音樂」的喜好程度為何？	□	□	□	□	□
8. 你對「電視、電影原聲帶」的喜好程度為何？	□	□	□	□	□
9. 你對「宗教音樂」的喜好程度為何？	□	□	□	□	□

10. 一年之中，你會去聽演唱會、音樂會、合唱團、演奏會等音樂類型的活動幾次？

    (A)0 次　(B)1～2 次　(C)3~4 次　(D)5~6 次　(E)7 次以上。

11. 一年之中，你會參與音樂活動幾次(如去 KTV 唱歌、組樂團表演、個人獨奏等)？

    (A)0 次　((B)1～2 次　(C)3~4 次　(D)5~6 次　(E)7 次以上。

12. 你認為聽音樂可以幫助你學習嗎？ (A)毫無幫助 (B)無幫助 (C)普通 (D)有幫助 (E)非常有幫助。
13. 你平均每天聽音樂的時間有多久？ (A)1 小時以內 (B)1~2 小時 (C)3~4 小時 (D)2~3 小時 (E)3 小時以上。
14. 你**最常**在什麼情況下聽音樂？ (A)從不聽 (B)讀書 (C)課間 (D)上課中 (E)休息 (F)洗澡 (G)搭車 (H)運動 (I)休閒 (J)與朋友一起。
15. 若老師上課前想撥放音樂給同學聽，你認為聽哪一類型的音樂**最**能幫助你進入學習狀況？ (A)古典音樂 (B)流行音樂 (C)搖滾音樂 (D)饒舌歌、嘻哈 (E)爵士樂、藍調 (F)民族、民俗、民間音樂 (G)電視、電影原聲帶 (H)宗教音樂。

    請提供曲目名稱，好讓老師幫大家找到音樂：______________________________

    例：選(G)，然後曲目是賽德克巴萊片尾曲。

Appendix D

個人背景

1. 在學校你**<u>最</u>**喜歡哪一個科目？

   (A)國文　(B)英文　(C)數學　(D)社會　(E)自然　(F)藝能科　(G)體育。

2. 父母是否從事與科學有關工作？ (A)兩者皆否 (B)僅父親 (C)僅母親 (D)兩者皆是

3. 父母是否從事與音樂相關工作？ (A)兩者皆否 (B)僅父親 (C)僅母親 (D)兩者皆是

4. 你會彈奏什麼樂器？ (A)不會任何樂器　(B)管樂　(C)弦樂　(D)打擊樂　(E)鋼琴

5. 若你會彈奏樂器，你一天彈奏樂器的時間有多久？

   (A) 1 小時以內　(B) 1~2 小時　(C) 2~3 小時　(D) 3~4 小時　(E) 4 小時以上。

Appendix E

教學進度與內容

授課大綱	預定教學進度		教學內容
日　期	章節（課）	教學單元	
10/19 (三)	1-4	日、月、月相	1. 人類以地球繞日公轉、月球繞地公轉以及地球自轉的運動劃分年、月、日。 2. 恆星日與太陽日。 3. 恆星月與朔望月。
10/26 (三)	1-4	年、陽曆、閏年	1. 恆星年與回歸年。 2. 陽曆的演變。 3. 陽曆與閏年的設置。
11/2 (三)	1-4	陰曆、農曆、閏月	1. 陽曆、陰曆與農曆的依據不同。 2. 二十四節氣與陽曆的關係。 3. 農曆與閏月的設置。
11/9 (三)	1-5	晝夜與四季 **報告：日晷的種類**	1. 因為地球自轉軸傾斜，所以造成不同季節太陽的入射角不同，及晝夜長短不同。 2. 太陽在不同季節時，日出、正午與日落方位不同。 3. 日晷的種類。