

# The Physics of Music with Interdisciplinary Approach: A Case of Prospective Music Teachers

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## Abstract

Physics of music is an area that is covered by interdisciplinary approach. In this study it is aimed to determine prospective music teachers' level of association with physics concepts which are related to music. The research is a case study which combines qualitative and quantitative methods. Eighty-four students who were studying at the Department of Music Education participated to the study. A data collection instrument which included qualitative and quantitative items with an interdisciplinary approach was used in this research. The collected data were grouped and analyzed by finding percentage value for each item. The findings from the data analysis were interpreted and a case assessment was made. In addition it was asked if it was necessary to take such an education. The findings revealed that most participants were unaware of musical concepts relating to physics and had difficulty in associating these concepts or expressing what they know. However, a great majority thought that such an education was necessary in their department.

**Keywords:** Interdisciplinary approach, Physics of music, Prospective music teachers, Music education

## 1. Introduction

The interdisciplinary approach gains more and more significance by the day. This approach is consistent with our holistic way of natural thinking and is highlighted more and more as it contributes a lot to effective and significant learning. Although it is not a new approach, it has become as prominent in the literature as it has in educational practices in recent years (Marrongelle, 2001; Rossiter, 2002; Courtney, 2006; Fleming, 2007; Van der Veen, 2007; White & Carpenter, 2008; Crowther, 2012; Lipszyc, 2012; An, Capraro & Tillman, 2013; Cabedo-Mas, Monferrer-Sales & Lorenzo-Valentín, 2014).

A 'discipline' is the name given to a field of research with an educational infrastructure, methodology and content of its own, which has proved that it can produce new and further knowledge within its boundaries (Berger, 1970). Put another way, a discipline is specialized knowledge with its own educational background, methodology, and content (Piaget, 1972). Each discipline has its own teaching, professional jargon, terminology, forerunners, and followers (Becher, 1989; Parker, 2002).

According to Jacobs (1989), the interdisciplinary approach is a programming mentality which uses the methodology and knowledge of more than one discipline in order to study a particular theme, concept, or problem. It is a conceptual integration of the concepts in different disciplines according to Erickson (1995) and a series of undertakings requiring more or less integration of disciplines according to Stember (1998).

In all definitions for the interdisciplinary approach which have been given so far, Lake (1994) observes:

- A combination of subjects,
- Importance attached to plans,
- Use of materials in addition to course books,
- Relationships among concepts,
- Use of relevant units,
- Flexibility in curriculums.

The interdisciplinary approach is the process used when a very large or complex issue cannot be explained through a single discipline. It is about a holistic approach from a wider perspective than the disciplinary approach (Newell, 1998).

Although the interdisciplinary approach is viewed as a twentieth-century term, it has a historical background. It has a significant place especially in Greek philosophy. Further, the studies and debates on the interdisciplinary approach so far show that it focuses on holistic education, the objective of which is learning for everyone (Chrysostomou, 2004).

The idea of integration through an interdisciplinary approach is first seen in Plato's *Politeia*. Plato was in the opinion that harmonics units were needed in education. New ideas parallel to this view have emerged centuries later. Rousseau, Dewey, Vygotsky, Gardner's work in education had much to contribute to the interdisciplinary approach (Ellis & Fouts, 2001; Chrysostomou, 2004).

Scientific and technological advances in recent years have led scientists, engineers, social scientists, and experts in other fields to adopt the perspectives of different disciplines in order to find answers to more complex problems. When we look at present-day issues, it is noticed many that require an interdisciplinary approach: nanotechnology, genetics, proteomics (science of proteins), bioinformatics, etc. Much knowledge acquired through research is again yielded by the interdisciplinary approach and cooperation: the discovery of the genome, magnetic resonance imaging, laser eye surgeries, radars, manned space missions, etc.

In time, the interdisciplinary approach has evolved into the 'multidisciplinary', 'crossdisciplinary' and 'transdisciplinary' approaches. Piaget (1972) and Meeth (1978) define the multidisciplinary approach as more than one discipline focusing on a subject without integrating. The crossdisciplinary approach involves looking at a discipline from the viewpoint of another discipline (Meeth, 1978). The word 'trans' in the transdisciplinary approach suggests removing all boundaries between fields and going beyond those fields. The aim is to acquire the necessary knowledge and reach a common perspective in order to understand the future world (Nicolescu, 2000).

Flinterman et al. (2001) note the following comparison between the transdisciplinary approach and the single-disciplinary, multidisciplinary and interdisciplinary approaches: The single-disciplinary approach remains within the boundaries of a single research field, domain, or expertise. Those working on a single discipline study the same subjects, apply the same methods, adopt the same conceptual structures and speak the same jargon. The multidisciplinary approach involves cooperation between the concepts, theories and methods of various disciplines without integrating, for a particular problem or issue. The interdisciplinary approach involves cooperation of more than one discipline. In this case, it is existed various concepts, theories and methods merging into a whole. Different disciplines intermingle and mutual enrichment results. The transdisciplinary approach is a special case of the interdisciplinary approach, where boundaries between fields are opened up and expanded.

Music and consequently, its basic building blocks –vibration and sound– are in relation with many disciplines. Figure 1 shows an interdisciplinary model of these relations (Eagle, 1996). It follows that, instead of a single definition of music, various definitions from different perspectives (sociological, psychological, acoustic, political, etc.) are needed. There are great differences between a sociologist's approach to music and an acoustic physicist's, in terms of both definition and methodology.

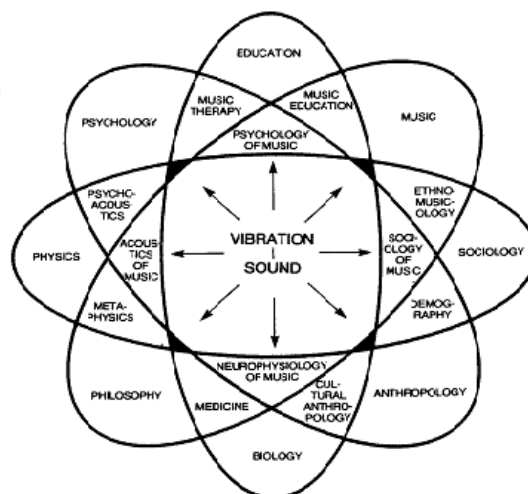


Figure 1. Relations between vibration and sound with other disciplines

Many subjects in music are related to physics and as a result, to mathematics. A connection from related definitions of music, physics, and mathematics would have music defined as a multitude of sentences of musical terms that arises from a number of simple sounds in an orderly sequence, complying with certain rules, which correspond to the rules of logic in mathematics and to the laws of nature in physics.

The subject of this study, physics of music, is one that requires a crossdisciplinary approach. According to Rogers (2004), music is a perfect interdisciplinary subject due to its natural intersection between science and mathematics. Designing interdisciplinary courses could enhance the perspectives of music teachers who think their subject is special and different from other disciplines. Music is indeed a special subject but not as different from other disciplines as commonly thought (Rogers, 2004). Music is axiomatic like mathematics. In order to fully appreciate music, listeners should learn its axioms. This learning does not require conscious studying but is based on the link between creativity and quantitative intelligence. Consequently, music could be used as a tool in physics, mathematics and engineering (Gibson, 2009).

The primary objective of music education is to help students form their identities, develop their creativities and prepare for life. Music is a basic and autonomous subject, in relation to other forms of art. In educational planning at all levels, its relation to other fields must be taken into account. For an interdisciplinary approach, the planning should include paradigms supporting the link between music and language, mathematics, physics, geography, sociology, art, poetry, history, religion and philosophy. This way, curricula would be more flexible and less rigid (Chrysostomou, 2004).

In music, the examination of sound sources from all aspects (timbre, pitch, resonance, harmonics, etc.), what could be done for better sound transmission, factors affecting the environment of sound transmission all fall into the domain of physics. In this context, the disciplines of physics and music are intricately linked. An equipped music teacher would therefore be expected to have an awareness of basic physics as it relates to music.

In the literature, there are many studies about pre- and in-service education in music teacher education (Conway, 2002; Ballantyne & Packer, 2004; Ballantyne, 2007; Bernard, 2009; Burwell & Shipton, 2011; Freer & Bennett, 2012). Several studies on the physics of music, which is an interdisciplinary subject, also can be found in the literature and considered as a basis for this study (Kelly & Chen, 1999; Hodges, 2003; Longair, 2006; Caleon & Supramaniam, 2007; Caleon & Ramanathan, 2008; Frederickson, 2010). However, educational applications of the physics of music are not so readily available. Fllies & Fouts (2001) attribute this to the difficulty of experimental studies with an interdisciplinary approach.

To date there has been no educational research considering of the physics of music in Turkey. In this study it is aimed to determine prospective music teachers' level of association of physics concepts which related to music.

## **2. Method**

This research is a case study which qualitative and quantitative methods are used together. The research sample consists of 84 students in their first, second, third, and fourth years at the Department of Music Education in the School of Education in Samsun, Turkey.

The musical concepts relating to physics were identified for this study. A data collection instrument which consisted of qualitative and quantitative items was designed by following a review of the literature, basing upon the 'Music and Science' unit in the eighth grade science and technology course book and administered to the students at the Department of Music Education. Some of the items in the data collection instrument are original questions designed by the researchers. This data collection instrument was checked by field experts, field instructors, and experienced teachers. The items in the data collection instrument were grouped according to concepts such as resonance, frequency (pitch, highness of the sound), velocity of sound, intensity of sound (volume, loudness, amplitude) and harmonics (overtones) as shown in Table 1. A total of nine items, multiple-choice as well as open-ended, were selected. The participants were asked a further three open-ended questions on whether they thought an education on this subject would be necessary. The items in the data collection instrument are given in Appendix A.

Table 1. Groups according to the concepts of qualitative and quantitative questions

Groups	Concepts	Qualitative Questions	Quantitative Questions
Group 1	Resonance	1	
Group 2	Concept Matching	2	
Group 3	Frequency (Pitch, Highness of the Sound)	3, 6	6, 9
Group 4	Velocity of Sound	4	4
Group 5	Intensity of Sound (Volume, Loudness, Amplitude)	5	5, 7
Group 6	Harmonics (Overtones)	8	8

A descriptive method was used for data analysis. The percentage values of the quantitative data were calculated on the computer. The qualitative data were separated into groups, with each item individually analyzed. The correct and incorrect answers were grouped for each question and the percentage values were found. The findings from the data analysis were interpreted and a case assessment was made. The students were further asked to identify the discipline to which music was related, as far as the test items suggested and to express their views on whether an education in that discipline would be necessary in their department.

### 3. Results

In this section there are the tables showing the percentages of the answers given to the qualitative and quantitative questions grouped in the data collection instrument. Percentages of qualitative explanations were calculated for each quantitative answer individually.

#### Group 1: Resonance

First item in the data collection instrument is about resonance. It is only qualitative question. Table 2 shows the percentages of the correct answers the students gave to the question on “resonance” from among the groups of qualitative questions.

Table 2. Percentages of the correct answers to the question on “resonance” from among the groups of qualitative questions (Item 1)

Quantitative Answer Given (Percentage)	Qualitative Explanations (Percentage)	
	Partially Correct Explanations (Percentage)	
	Incorrect Explanations (Percentage)	
<b>Guitar*</b> (84,5%)	<p><b>The structure of the body of the guitar brings sound together. (59,1%)</b></p> <p><b>Because sound hits the body of the guitar. (2,8%)</b></p> <p>No explanation (25,5%)</p>	<p>The string is tense. (7%)</p> <p>The wooden body of the guitar transmits sound and amplifies its frequency. (5,6%)</p>
String (9,5%)	<p><b>Incorrect Explanations (Percentage)</b></p> <p>Timbre continues on the string. (12,5%)</p> <p>Pressure is excessive. (12,5%)</p> <p>Tension is excessive. (12,5%)</p> <p>The string gives out more sound. (25%)</p> <p>No explanation (37,5%)</p>	
Blank (6%)		

\* Correct Answer

**Group 2: Concept Matching**

Although they have nearly same meanings, some concepts are used with different words in physics and music in Turkey. Students were asked to match the words which have nearly same meanings. Second item in the data collection instrument is about these concepts' matching. It is only qualitative question. Table 3 shows the students' answers and their percentages for the question on the association of concepts in group two from among the groups of qualitative questions.

Table 3. Answers and percentages for the question on the “association of almost identical concepts in music and physics” from among the groups of qualitative questions (Item 2)

Answer Given (Percentage)			
<b>intensity-volume-loudness-amplitude*</b>	<b>overtones-harmonics*</b> (41%)	<b>frequency-highness of the sound-pitch*</b> (3,4%)	<b>timbre-colour of sound* (67,8%)</b>
intensity-volume (3,4%)		Frequency-highness of the sound (32,2%)	
intensity-loudness (55,9%)		frequency-pitch (16,9%)	
volume-loudness (3,4%)		highness of the sound-pitch (5,1%)	
Mismatched (21,4%)			
Blank (8,3%)			

\*Fully Correct Answer

**Group 3: Frequency (Pitch, Highness of the Sound)**

Third, sixth and ninth items in the data collection instrument are about frequency (pitch, highness of the sound). Item 3 is only qualitative and item 9 is only quantitative question. But item 6 is both qualitative and quantitative question. Table 4 shows the students' answers and their percentages for question three on “frequency (pitch, highness of the sound)” in group three from among the qualitative questions.

Table 4. Percentages of the correct answers to the question on “frequency (pitch, highness of the sound)” from among the groups of qualitative questions (Item 3)

Answer Given	Percentage (%)
Correct answers	26,2
Incorrect answers	63,1
Blank	10,7

Table 5 shows the students' answers and their percentages for question six on “frequency (pitch, highness of the sound)” in group three from among the qualitative questions.

Table 5. Answers and percentages for the question on “frequency (pitch, highness of the sound)” from among the groups of qualitative questions (Item 6)

<b>Quantitative Answer Given (Percentage)</b>	<b>Qualitative Explanations (Percentage)</b>	
	<b>Correct Explanations (Percentage)</b>	<b>Incorrect Explanations (Percentage)</b>
<b>A*</b> (78,6%)	<b>Frequency ranges are frequent.</b> (23,9%)  No explanation (68,6%)	The sound is more intensive. (5,9%)  Sound arrives as a whole. (1,6%)
<b>B</b> (4,8%)	No explanation (100%)	
<b>C</b> (4,8%)	No explanation (100%)	
<b>D</b> (11,8%)	<b>Incorrect Explanations (Percentage)</b> The frequency range is wider. (30%) No explanation (70%)	

\* Correct Answer

Table 6 shows the percentages of students’ answers for question nine on “frequency (pitch, highness of the sound)” in group three from among the quantitative questions.

Table 6. Percentages for the question on “frequency (pitch, highness of the sound)” from among the groups of quantitative questions (Item 9)

Answer Given	Percentage (%)
<b>B</b> Thin-long	53,6
<b>C</b> Thick-long	13,1
<b>D* Thin-short</b>	33,3

\* Correct Answer

#### **Group 4: Velocity of Sound**

Fourth item in the data collection instrument is about velocity of sound. It is both qualitative and quantitative question. Table 7 shows the students’ answers and their percentages for question four on “velocity of sound” in group four from among the qualitative questions.

Table 7. Answers and percentages for the question on the “velocity of sound” from among the groups of qualitative questions (Item 4)

<b>Quantitative</b> Answer Given (Percentage)	<b>Qualitative</b> Explanations (Percentage)	
A Gas (14,3%)	<b>Incorrect Explanations (Percentage)</b>	
	Sound conductivity is higher in the gases. (16,7%)	
	Air has more oxygen. (8,3%)	
	It hits obstacles more and bounces back more in the gases. (8,3%)	
	Sound waves get vibration better in the gases. (8,3%)	
No explanation (58,4%)		
B Vacuum (71,4%)	There are no obstacles slowing down sound in vacuum. (37,3%)	
	Sound frequency spreads faster in vacuum. (1,7%)	
	More acoustic environment occurs in vacuum. (15,3%)	
	Sound echoes in vacuum. (10,2%)	
	No explanation (35,5%)	
C Solid* (9,5%)	<b>Correct Explanations (Percentage)</b>	<b>Incorrect Explanations (Percentage)</b>
	<b>There is less space between the molecules of solids. (28,6%)</b>	Solids transmit to all points. (14,3%)
	<b>Solids transmit sound quickly. (28,6%)</b>	Solids have higher density. (14,3%)
	No explanation (14,3%)	
D Liquid 4,8%	<b>Incorrect Explanations (Percentage)</b>	
	Transfer is more in liquids. (25%)	
	In a liquid environment, sound waves spread further. (25%)	
	No explanation (50%)	

\* Correct Answer

**Group 5: Intensity of Sound (Volume, Loudness, Amplitude)**

Fifth and seventh items in the data collection instrument are about intensity of sound (volume, loudness, amplitude). Item 7 is only quantitative question and item 5 is both qualitative and quantitative question. Table 8 shows the students' answers and their percentages for question five on “intensity of sound (volume, loudness, amplitude)” in group five from among the qualitative questions.

Table 8. Percentages of the answers given to the question on “intensity of sound (volume, loudness, amplitude)” from among the groups of qualitative questions (Item 5)

<b>Quantitative</b> Answer Given (Percentage)	<b>Qualitative</b> Explanations (Percentage)
A (2,4%)	No explanation (100%)
<b>B</b> (36,9%)	<b>Incorrect Explanations (Percentage)</b>
	Sound ripple is less. (4,2%)
	Frequency of the sound wave is excessive (high-pitched). (33,3%)
	No explanation (62,5%)
<b>C*</b> (60,7%)	<b>Partially Correct Explanations (Percentage)</b>
	<b>Volume of the sound wave is excessive. (The sound is louder.) (32,7%)</b>
	<b>Incorrect Explanations (Percentage)</b>
	Frequency of the sound wave is higher. (16,3%)
	It is audible at wider intervals. (12,2%)
	The wavelength is longer. (6,3%)
	No explanation (32,5%)

\* Correct Answer

Table 9 shows the percentages of students’ answers for question seven on “intensity of sound (volume, loudness, amplitude)” in group five from among the quantitative questions.

Table 9. Percentages for the question on “intensity of sound (volume, loudness, amplitude)” from among the groups of quantitative questions (Item 7)

Answer Given	Percentage (%)
A Decrease the frequency of sound waves	9,5
<b>B*</b> <b>Decrease the intensity of sound waves</b>	64,3
C Increase the intensity of sound waves	1,2
D Decrease the frequency and intensity of sound waves	25

\* Correct Answer

### **Group 6: Harmonics (Overtones)**

Eighth item in the data collection instrument is about harmonics (overtones). It is both qualitative and quantitative question. Table 10 shows the students’ answers and their percentages for question eight on “harmonics (overtones)” in group six from among the qualitative questions.



Table 10. Percentages of the answers given to the question on “harmonics (overtones)” from among the groups of qualitative questions (Item 8)

<b>Quantitative</b>	<b>Qualitative</b>	
Answer Given (Percentage)	Explanations (Percentage)	
	<b>Incorrect Explanations (Percentage)</b>	
A	It is one octave higher. (2,1%)	
(61,9%)	The sound spreads wider. (2,1%)	
	Volume and pitch of the sound are identical. (4,2%)	
	The string gets tenser. (2,1%)	
	The pitch is amplified. (10,4%)	
	The volume is amplified. (6,2%)	
	No explanation (72,9%)	
<b>B*</b>	<b>Partially Correct Explanations</b>	<b>Incorrect Explanations</b>
<b>(16,7)</b>	<b>(Percentage)</b>	<b>(Percentage)</b>
	<b>Higher-pitched sound occurs when it is pulled closer to the bridge of the guitar. (14,3%)</b>	The frequency is higher because the applied force is more magnitude. (14,3%)
		There is more tension. (21,4%)
	No explanation (50%)	
C	<b>Incorrect Explanations (Percentage)</b>	
(21,4%)	Volume changes but frequency does not. 34%	
	No explanation 66%	

\* Correct Answer

The students were further asked to identify the discipline to which music was related, as far as the test items suggested and to express their views on whether an education in that discipline would be necessary in their department. The prospective music teachers taking part in the study were asked what discipline they linked with music and percentages of their answers are given in Table 11.

Table 11. Disciplines linked with questions in data collection instrument which are related to music

<b>Disciplined</b>	<b>Percentages (%)</b>
Physics	76,2
Science	2,4
Mathematics	2,4
Physiological Structure of Music	2,4
Logic	1,2
Analyze of Sound	1,2
Birth of Sound	1,2
Sound Engineering	1,2
Blank	11,8

The participants were asked if their department offered them an education about the discipline they linked with music and 82.1 % of them said they received no education while the remaining 17.9 % said they superficially touched upon those subjects in their singing and individual instruments lessons.

Table 12 shows the participants' views on whether an education about the disciplines given in Table 11 would be necessary at their own department.

Table 12. Participants' views on whether an education about the disciplines related to music would be necessary at their own department

<b>Answer Given (Percentage)</b>	<b>Explanations</b>
I consider it necessary. (73,9%)	I consider it necessary for those wishing to study further in certain parts of music such as making instruments, sound technicians, musicology or master's degree.  I consider it necessary after this questionnaire. If we are interested in music, we should learn about it in all aspects. We do not know much about those subjects – I think it would be useful. It would enable us to learn about the scientific aspect of what we are doing.
I consider it unnecessary. (26,1%)	

#### 4. Discussion

The quantitative and qualitative questions in the data collection instrument were grouped according to concepts such as resonance, frequency (pitch, highness of the sound), velocity of sound, intensity of sound (volume, loudness, amplitude) and harmonics (overtones).

Inconsistent answers given to different questions on the similar concepts show that the participants have an incorrect or inadequate knowledge about these concepts.

The percentage of the correct answers given to the qualitative question about "resonance" in the data collection instrument about the association of common concepts in physics and music was 84.5%. Despite this high percentage, their explanations revealed that prospective music teachers had certain misconceptions or a lack of knowledge about resonance as a concept.

Even though the great majority of the participants correctly answered the question on resonance, they did not express the concept of resonance in their explanations. Despite explanations that might lead to the answer of resonance, the participants were unable to tell that this was indeed resonance. This shows that the participants did not know about this concept as a term or they had difficulty associating the concept, which is common to the disciplines of both music and physics.

Although they have nearly same meanings, some concepts are used with different words in physics and music in Turkey. Students were asked to match the words which have nearly same meanings. Findings from second item in the data collection instrument show that students have difficulties to match these concepts.

The data suggest that the participants did not think that frequency (pitch, highness of the sound) was related to the sound being high or low pitched. The participants were unable to associate frequency with the length of a sound cord. The concepts of volume and frequency were found to be confused or used interchangeably. Regarding the concept of volume, the participants linked the audibility of sound from a distance to its being high or low pitched and thought that lowering the volume of a source of sound was about frequency.

One of the most striking findings was the participants' misconception about the velocity of sound. Most of them believed that the velocity of sound would be low in solid matters, which corroborates the findings of Hrepic (2004). The participants thought that sound would travel the fastest in vacuum. They also thought that sound needed no material environment to travel and sound could spread in vacuum which is in line with the findings of Linder (1992), Maurines (1993) and Hrepic (2002).

The participants also had many misconceptions about the velocity of sound. A survey of the answers to the multiple-choice questions reveals their beliefs that:

- Sound can travel in vacuum.
- There is no need for a material environment for sound to travel.
- Sound is more audible through echoes when it travels large distances in the air.
- Sound travels faster in the air as there are no obstacles on its way.

The participants' answers to the questions about intensity of sound (volume, loudness, amplitude) also revealed certain misconceptions:

- The audibility of sound from a distance is only linked to its being high or low pitched.
- Volume and frequency are confused.
- Lowering the volume of a source of sound is about frequency.

Results show that their performance in question about harmonics (overtones) was found to be poor. Researchers had expected that participants could answer the question about harmonics correctly without knowledge of terminology and physics. This might suggest that they had difficulty transferring their daily-life skills. Harmonics are important because timbre can be explained according to harmonics.

As for suggestions, the following can be put forward:

- Studies highlighting the importance of the interdisciplinary approach in education could be made more readily available.
- This study focused on students at the department of music education. Similar studies could be conducted on different levels at different departments.
- Based on this study, further studies could also find out and compare the knowledge levels of music, physics, and science and technology teachers in this field.
- In science and technology curricula, sound is associated with music. Likewise, in music courses, sound could be associated with science and technology or physics.
- Courses in the physics of sound or physics of music could be offered at schools of fine arts, departments of music education and music colleges in order to highlight common basic concepts in music and physics.
- Similar research could be done not only in music and physics but in all fields open to integration.
- Experimental studies could be conducted based on comparisons with different approaches in order to test the efficiency of the interdisciplinary approach.
- The interdisciplinary approach could be studied at curriculum-development level.
- The efficiency of the interdisciplinary approach could be studied with different variables such as student participation and motivation, performance, collaboration and problem-solving skills.
- Teachers could be offered pre- and in-service education in the interdisciplinary approach, so that they could use it more effectively in their profession.
- Teachers could design interdisciplinary activities with musical instruments when teaching music, science and mathematics.

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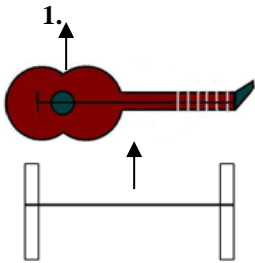
**APPENDIX A**

**Questions Applied to Prospective Music Teachers**

**Explanation:** This scale is developed to determine how students -who study at the Department of Music Education in the Faculty of Education at Samsun Ondokuz Mayıs University- relate between some theoretical knowledge in music area and other branches of science. All questions must be read and answered carefully to provide reliability for the results. Thanks to everyone...

**Student's;**  
**Class:**  
**Instrument Played:**  
**High School Graduated:**  
**Gender:**      **Female**       **Male**

**QUESTIONS**



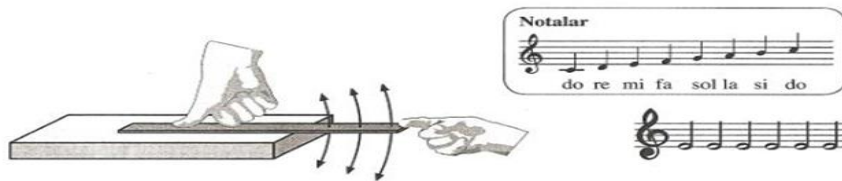
Two strings which are made of same material, same thickness and length are connected to the guitar and wooden sticks as shown. Each string is pulling up in the direction indicated by the arrow. Which tune sounds more intensive? Why?

.....  
 .....  
 .....

2. There are some concepts related to sound below. Group these concepts which have nearly similar meanings. (Each group consists of two or more concepts.)

intensity – amplitude – color of sound – overtones – frequency – harmonics – volume-  
 highness – loudness– pitch – timbre

3.



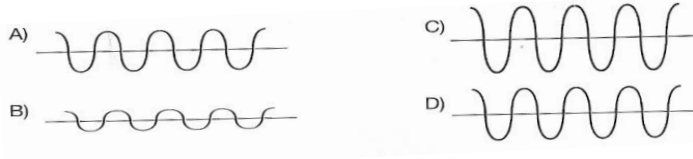
In the figure above, the sound of a vibrating ruler is represented by note. The sound above is accepted as the note “E”. Write a note to each of the following figures by considering if it is high or low pitch. (Notes shown on the strings do not have the actual frequency value. They were only symbolic.)

4. In which of the following, sound propagates faster? Why?

- A) Gas      B) Vacuum      C) Solid      D) Liquid

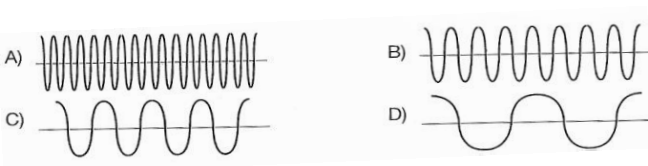
.....  
 .....

5. Which sound wave on the following graphs can be heard easier from a distance? Why? (Frequencies of sound waves are equal.)



.....  
 .....

6. Which sound wave on the following graphs has the highest frequency? Why?



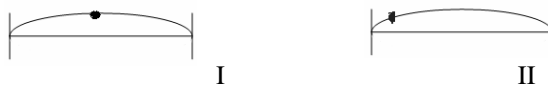
.....  
 .....

7. When your friend ask you to mute the radio she/he means .....

Complete the sentence with the suitable one following.

- A) Decrease the frequency of sound waves
- B) Decrease the intensity of sound waves
- C) Increase the intensity of sound waves
- D) Decrease the frequency and intensity of sound waves

8.



There are two strings with same length and thickness and equal tension strength above. First one is pulled from mid-point of the string and second one is pulled from the closer side of the stick as shown above with same force. Which of the following is true for the sounds? Why?

- A) First wire's frequency is more. ....
- B) Second wire's frequency is more. ....
- C) Both have the same frequency. ....

9. Which of the following belongs to the high pitched sound?

- A) Thick-short      B) Thin-long      C) Thick-long      D) Thin-short

Thanks for answering the questions above.

- Which discipline is related to music according to questions above?
- Are you offered an education at your department in this discipline as it relates to music?
- Do you believe such an education would be necessary?