

Material Design in Music Education Using Arduino Platform *

Arduino Platformu Kullanılarak Müzik Eğitiminde Materyal Tasarımı

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Abstract. In this study, the aim is to design visual and audio materials that facilitate learning in music education by using Arduino platform. In this study, secondary school music lesson program was examined and various materials were designed in line with this program. The designed materials were presented to the 10 music teachers for their opinions. Interview data were analyzed by descriptive analysis. In the light of the data obtained; it has been concluded that the constructed materials for the secondary school music lesson program are suitable for the curriculum, can be easily used by students and music teachers, and positively affect student success. It is recommended that these materials are included in the teacher's manual prepared by the Ministry of National Education for primary and secondary schools.

Keywords: Arduino, material, teaching material, materials in music education.

Öz. Bu çalışmada, Arduino platformu kullanılarak müzik eğitiminde öğrenmeyi kolaylaştırıcı görsel ve işitsel materyallerin tasarımı amaçlanmıştır. Çalışmada, ortaokul müzik ders programı incelenmiş ve bu program doğrultusunda çeşitli materyaller tasarlanmıştır. Tasarlanan materyaller 10 müzik öğretmenin görüşlerine sunulmuştur. Görüşme verileri betimsel analiz yapılarak işlenmiştir. Elde edilen veriler doğrultusunda; ortaokul müzik dersi programına yönelik olarak hazırlanan materyallerin ders programına uygun olduğu, öğrenciler ve müzik öğretmenleri tarafından rahatlıkla kullanılabilir olduğu ve materyallerin öğrenci başarısını olumlu yönde etkileyeceği sonuçlarına ulaşılmıştır. İlkokul ve ortaokul için MEB tarafından hazırlanan öğretmen klavuz kitabına bu materyallerin koyulması önerilmektedir.

Anahtar Kelimeler: Arduino, materyal, öğretim materyali, müzik eğitiminde materyaller.

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Introduction

When we look at the historical course, we see that tools (materials) suitable for the development of humanity have been designed and used. In this course, the materials made it easier for people to do their jobs in every field and provided great convenience in their lives. The materials, which are renewed every year with the development of science and technology, have become an indispensable part of our lives by displaying themselves as teaching materials in educational activities today.

The main purpose of using instructional material is to increase the effectiveness of the process and increase the efficiency of education. In order to increase the efficiency of education, it is necessary to prepare high quality, striking and accurate materials that can be reused after a certain period of time (Ördekci, 2016; p. 33). The idea is that information will be materialized and the students' acquaintance will be at the highest level with the effective use of appropriate materials especially in the teaching of an abstract concept such as "music".

Concept of Instructional Material

Materials can be defined as materials / documents that are selected in order to reach the targets and organized in line with certain principles, the content of which is designed in audio, visual and written form (Gürman, 2019; p. 9). The materials used in the studies and researches carried out in order to convey information to students in educational activities and to enable the teacher carry out learning activities efficiently and to make the transferred information concrete (Şimşek, 2004; p. 116). For efficient teaching, ancillary tools should be used. Teaching materials are at the top of these tools list. Although teaching materials are used to support teachers in some teaching environments, in other settings, they play the role of a teacher and transfer the content directly to students (Şahin & Yıldırım, 1999; p. 12). Materials that provide concrete instruction contribute to students learning by doing and practicing. Thus, teaching materials become effective tools to improve the quality of education.

Teaching materials prepared by the teacher during the learning process and presented to students in different environments (Danış, 2007; p. 60) are used to support the teaching-learning process, in order to facilitate learning in this process and to make the education more efficient, to provide effective and permanent learning environments by addressing multiple senses of students (Demiralp, 2007; Alım, 2007; Gündüz & Odabaşı, 2004). In this context, it is believed that various teaching materials prepared for the purposes of the course will make student learning more effective.

The literature indicates that there are many benefits of using materials in teaching environment. Accordingly, the use of materials brings the student to the center, provides richer learning opportunities, provides a multi-learning environment, makes the subject taught alive, enriches the learning process and enhances learning, ensures the permanence of what is learned, facilitates remembering, helps to increase student motivation, helps to meet the individual needs of students, it embodies abstract concepts and saves time. The materials are also important because they can be used repeatedly, simplify the content, make it easier to understand, provide feedback, attract attention, and make the learning-teaching process more interesting (Gürman, 2019; Duman, 2013; Kablan, Topan & Erkan, 2013; Demiralp 2007; Gürbüz, 2006; Şahin & Yıldırım, 1999).

Enriching the lesson by using different materials, the trainer ensures that the teaching is carried out in a concrete way, thus contributing to the learning of the students by doing and experiencing and making their lessons more effective. It is thought that a good trainer should be able to use teaching materials as an effective tool to improve the quality of education, follow new materials designed in the field, develop new ones and use them in their lessons.

Although the teaching materials do not replace the teacher, they almost assist the teachers in conveying the information to the students (Gündüz & Odabaşı, 2004; p. 45; Şahin & Yıldırım, 1999; p. 12).

The more senses the teaching activity addresses, the more permanent the learning is, and the later the forgetting delays (Demirel, 2007; p. 65). According to the results of the research conducted by Philips at the University of Texas; people remember 10% of what they read, 20% of what they hear, 30% of what they see, 50% of what they see and hear, 80% of what they see, hear and say, 90% of what they see, hear, touch and speak about (Kinder, 1973; cited in Çilenti, 1992; p. 36). According to Ted Cobun, people learn through the experiences they have acquired with the senses of seeing 83% of what they see; 11% of what they hear, 3.5% of what they smell, 1.5% of what they touch and 1% of what they taste (cited in Ergin, 1995; p. 66).

In line with this information, we can say that the materials prepared according to the acquisitions provide time-saving and permanent learning for the course, attract attention, accelerate learning by keeping them alive and constantly, they are remarkable, and they provide learning by doing and experiencing in concrete and systematic presentations.

In the literature, one may come across many studies in different fields related to the use of materials in education. Followings are some of these studies: Ördekci (2016) proposes a music education supported with visual materials and presents various visual materials that she prepared in line with the 4th grade music lesson program. Kablan et al., in their study in 2013, using meta-analysis, examined 57 studies conducted in Turkey. According to the data obtained from the study, it was concluded that the effectiveness level of the use of materials in classroom teaching is relatively high in terms of academic success. As in every education field, the use of materials is very important in music education too. In this regard, in the Music Teaching Program published in 2007; it is emphasized that the efficiency of the courses should be increased by using teaching materials (Dalmışlı, 2013; p. 1). In her study conducted in 2013, Dalmışlı states that when the subjects of the terms for the degree of strongness and the odd meters in the 4th grade music lesson in primary school are explained using visual and audio materials, the students understand better, listen to the lesson with pleasure and the teaching method by using the materials more efficient than the traditional music teaching methods. Akarsu (2007), in his study, affirms that the use of materials in music teaching lessons contributes to students' achievement levels, personal development, facilitates communication with the student and increases the efficiency of teaching activities. In addition, Akarsu (2007; p. 59) states that the music lessons have an abstract structure in terms of content, it will be difficult to convey the abstract concepts to the students in the transfer of educational activities, therefore there is need to use materials for music lessons. In his study, Öztürk (2004) tried to analyse whether the use of materials in the music lessons taught in primary schools is sufficient and whether the goal is achieved or not. As a result of the research; it has been determined that the use of materials is not sufficient in music lessons taught in primary schools, and even if it is

used, the existing materials do not reach their purpose completely because they are applied unconsciously.

Technology undoubtedly is the prime factor; that rapidly advances, allows audio and visual materials to be so important. Particularly, the development of information and communication technologies, computers, mobile phones and the internet is increasing the importance of visual and audio materials today (Akalin, 2012; cited in Demirkuş & Gülen, 2017).

It is thought that it is not possible to remain irrelevant to technological developments in today's world, from preschool classes to university curriculum. The increasing popularity of technology raises the idea that it should not be ignored in education, and the design and the use of technology-supported materials should become widespread. In this study, visual and auditory music teaching materials were designed using Arduino, a technologically supported platform.

What is Arduino?

Arduino is a microcontroller platform with open source software and hardware. Arduino's roots are based on the Wiring and Processing projects.

Wiring platform that inspired Arduino with Wiring; was developed in 2003 by Hernando Barragan at the Ivera Design Institute. Wiring is an open source electronic prototype development platform consisting of a single MCU board, an IDE and a programming language (Çobanoğlu, 2017; p. 2). Wiring, which is the master thesis of Hernando Barragan, who holds a master's degree from the Interactive Design Institute in Ivrea, Italy, was developed in order to easily develop interactive systems based on the processing project (Taşdemir, 2017; p. 5). Processing was developed by Ben Fry and Casey in 2001. It is a language that aims an easy programming environment for graphic applications, especially for artists (Çobanoğlu, 2017; p. 2).

The Arduino project was produced on the basis of Wiring by a team led by Massimo Banzi (Taşdemir, 2017; p. 5). Arduino started in Ivrea Italy in 2005 as an electronic control environment project consisting of an open source software and micro controller modules. They named the system inspired by Arduin of Ivrea, the historical character of the town of Ivrea. At the same time, Arduino means powerful friend in Italian. Its founders stated that they started to produce the system in order to be an inexpensive software-hardware platform that can be used in student-made interaction design projects (Çamoğlu, 2014; p. 12-13).

Arduino Models and Features

Since the Arduino cards used in the materials designed for the study are Uno, Mega and Nano, only these cards are described here.

Arduino Uno Hardware Features

Arduino Uno is a microcontroller board based on the Atmega328 microcontroller family. It has 14 digital input output ports in total and 6 of them are used as PWM (Pulse width modulation) output. They are pins 3, 5, 6, 9, 10, 11 in Figure 1 used as PWM, each working with 5V and 40

mA current. It provides 8 bit PWM output and is used in digital analog conversion processes. For example, for adjusting the motor speed or the burning intensity of the LED. Arduino Uno has 6 analog inputs, 16 MHz Crystal, 32KB program memory, 1KB EEPROM (Electrically Erasable Programmable Read-Only Memory), 2KB SRAM (Static Random Access Memory), 1 USB input, one feeding and It has a reset circuit. It uses serial communication protocols such as UART (Universal Asynchronous Receiver Transmitter), SPI (Serial Peripheral Interface) to communicate with peripheral units. Atmega328 UART provides TTL (5V) serial communication with RX (Receiver) and TX (Transmitter) (legs 0 and 1). It is understood that RX, TX LEDs on the Arduino board are flashing when communication occurs. Arduino's 10, 11, 12, 13 pins are the ones that enable SPI communication using the SPI library. In I2C (Inter-Integrated Circuit) serial data communication, A5 pin is used as SCL (Serial Clock) and A4 pin is used as SDA (Serial Data Line) line (Çobanoğlu, 2017; p. 34-35). In Figure 1, the image of Arduino Uno is given.



Figure 1. Arduino uno (<https://store.arduino.cc>, 2019)

Arduino Nano Hardware Features

Arduino Nano is a model that is quite small and designed for applications on the circuit board. It has an Atmega328 or Atmega168 microcontroller. Unlike the Uno board, it has 8 analog input output pins. Other hardware features are similar to Uno board. In Figure 2, the image of Arduino Nano is given.

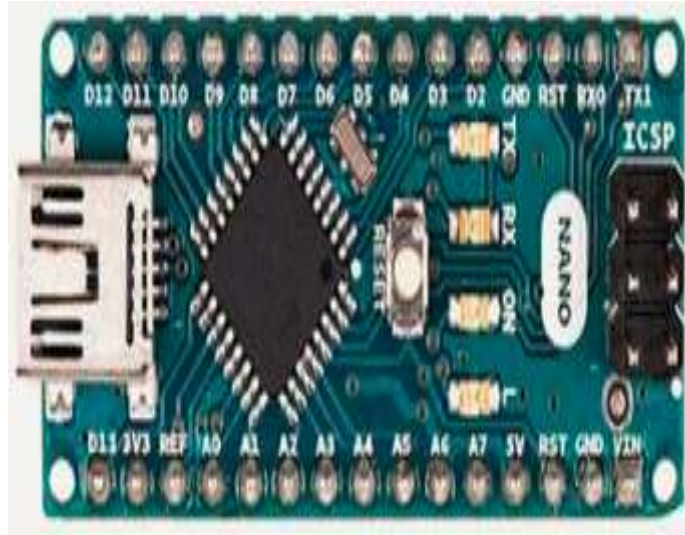


Figure 2. Arduino nano (<https://store.arduino.cc>, 2019).

Arduino Mega Hardware Features

Arduino Mega has Atmega2560 microcontroller. It has 54 digital input-output pins (15 of which can be used as PWM output), 16 analog inputs, 4 hardware serial ports (UART), 16 MHz operating frequency, 256 KB flash memory, 8 KB SRAM memory and 4 KB EEPROM memory. The image of Arduino Mega is In Figure 3.



Figure 3. Arduino mega (<https://store.arduino.cc>, 2019).

Using Arduino in Music Education

Technology practices in music lessons increase students' self-confidence, provide more efficient and effective learning and strengthen their group work (Arapgirlioğlu, 2003; p. 164). The use of technology is part of daily life. Applying these practices in daily life to music education with Arduino can make students learn more actively and easily by keeping their interests alive.

Arduino has been used in thousands of different projects and applications. For beginners in robotic coding, the Arduino software is easy to use and flexible enough for advanced users. Teachers and students can use the Arduino platform to create low-cost materials, chemists and physicists to prove their principles, designers and architects to create interactive prototypes, and musicians to design musical instruments (<https://www.arduino.cc>, 2019). That is why teachers and students need to know about coding.

The Information Technologies and Software Course Coding Guide has been offered to all students and teachers by the Ministry of National Education (MEB) in order to learn programming languages, the universal language of today and tomorrow, to develop new projects, to enable children to realize their dreams and to provide opportunities for the development of our country (MEB, 2018; p. 9). With the guide, lesson acquisitions were enriched with new projects and ideas for teachers and students. All devices used today work by programming with code languages. Coding education has an important role in ensuring interdisciplinary interaction. Thus, it is aimed to gain the ability to produce solutions to problems in different fields by providing operational thinking skills at an early age. Teachers can create remarkable and entertaining materials related to their fields by using the Arduino platform with coding and provide more permanent learning to the student.

With this information, we aim to design visual and audio materials that facilitate learning by using Arduino platform in music education. To do this, various materials were designed and these materials were presented to the evaluation of music teachers. This paper aims to seek the answers to the following questions in general:

1. Are the visual and audio materials designed using the Arduino platform prepared in accordance with the curriculum?
2. Can visual and audio materials designed using the Arduino platform be easily prepared and used by music teachers?
3. Do the visual and audio materials designed using the Arduino platform make the music lessons more effective and affect student success?

Method

This research is a study using the literature review and qualitative research methods. Literature review “A systematic, open and repeatable method for learning the current situation by finding, evaluating and synthesizing information produced by other theorists, researchers and practitioners on the subject being researched” (Fink, 2005; cited in Booth, Sutton & Papaioannou, 2016; p. 9-10), qualitative research, on the other hand, is a research in which data collection methods such as observation, interview and document analysis are used, and a

qualitative process for the realization of perceptions and events in a natural and holistic manner is followed (Yıldırım & Şimşek, 2018; p. 41). “Unlike quantitative research based on statistical data analysis, qualitative research seeks to answer the question of what meaning people attribute to events, in other words, how they characterize events” (Dey, 1993; cited in Özdemir, 2010; p. 325-326). Storey (2007) states that qualitative research aims to discover subjective perspectives of people on events and is therefore superior to quantitative research (cited in Özdemir, 2010; p. 326).

In this research, before analyzing the visual materials in music education, document analysis was done and data were collected. Document analysis can be defined as “collecting and analyzing written, visual material” (Sönmez & Alacapınar, 2018; p. 108). Visual data was examined in detail through visual analysis, which is treated as a subtitle of document analysis. “Visual analysis can be defined as the explanation and interpretation of visual data, symbols, signs” (Sönmez & Alacapınar, 2018; p. 112). In the research, considering the usability of Arduino in music education, various visual and audio materials were designed and interviews were conducted with 10 music teachers to get their ideas about these materials. Interviewing is the technique of getting emotions and thoughts from people about a certain subject (Sönmez & Alacapınar, 2018; p. 185). Structured, semi-structured and unstructured interview forms can be used to reveal individuals' perspectives on the subject. Structured interview form was used in this study. Structured interviewing is a technique that determines what kind of questions are asked in what way and what data will be collected, and the interview plan is tried to be applied exactly (Karasar, 2018; p. 212).

In the research, all the rules in the “Scientific Research and Publication Ethics Directive of Higher Education Institutions” were followed and none of the actions that are in contradiction with the Scientific Research and Publication Ethics in the second part of the directive were carried out.

Working Group

The study group of the research consists of 10 music teachers whose views are consulted to get their thoughts about the designed visual and audio materials. Music teachers who were asked for the views were chosen from among the teachers working in Afyonkarahisar, who attended or are currently attending classes in secondary school, so they know the middle school curriculum well, are successful and open to development, use materials in their lessons or know the technology well. 7 of the teachers who form the working group have working experience between 5-10 years and 3 of them have between 11-22 years. 6 of the teachers are women and 4 are men. In accordance with the scientific ethical rules, the names of the study group are kept confidential.

Collection of Data

In the research, the secondary school music lesson program and visual, written and printed materials were analyzed in line with this program, and the visual and audio materials that facilitate learning in music education were designed within the possibilities offered by the Arduino platform. The design and construction phase of the materials took six months. An interview form was prepared to get the opinions of the music teachers regarding the designed materials and 13 questions were included in the interview form. While preparing the interview

form, worked hard to make sure that the questions were understandable to everyone and that they did not include any direction. The interview form prepared as a draft was presented to the experts (2 professors) of the field of music education, and necessary corrections were made in the form in line with the comments and corrections of the experts. Interviews were made with 10 music teachers on a voluntary basis. Music teachers interviewed were given detailed information about the study and an informed consent forms were signed by all teachers. Interviews were conducted in environments where teachers are available (at schools, digital media and homes where they work).

Data Analysis

For the analysis of the data, the data obtained from the interview were transferred to the article and the responses of the participants were processed with the descriptive analysis method. In descriptive analysis, the data are summarized and interpreted under pre-determined titles. The data can be classified according to the research questions or it can be arranged in light of the preliminary information obtained during the data collection steps. The purpose of this analysis is to put the raw data in a shape that the readers can understand. The data obtained for this purpose was put in a logical order first, then these descriptions (classifications) are interpreted and the results are obtained (Altunışık, Coşkun, Bayraktaroğlu & Yıldırım, 2004; p. 234). In this type of analysis, direct quotations are included to dramatically reflect the views of the individuals interviewed. Quoting from data sources is also useful for the reliability of the study (Yıldırım & Şimşek, 2018; p. 239; Altunışık et al., 2004; p. 234). In this study, meaningful and interrelated classifications were made according to the research questions and explained systematically in the findings section. While presenting the findings, direct quotations from the statements of the teachers interviewed were also included.

Findings

General Findings

Findings for the general target of “Designing visual and audio materials that facilitate learning by using Arduino platform in music education” are as follows:

Materials Designed Using Arduino Platform in Music Education and Their User Guides

Among all the prepared materials, the achievements of the secondary school curriculum were considered and various materials were prepared within the possibilities offered by the Arduino platform. With the prepared materials, studies can be carried out with the teacher and individually.

Touch Music Box

Table 1 lists the sub-materials for different use of the touchscreen music box. The purpose and material list of the material are included in the table. It is also possible to support different gains with the touch music box.

Table 1.

5th, 6th, 7th and 8th Grade Achievements of the Touch Music Box and the Tools and Equipment Used

<u>Materials</u>	
Weighing and Instrument Cards, Fruit Instrumnets, Piano Floor Mat	
<u>Achievements</u>	
<u>5th Grade</u>	<u>6th Grade</u>
<ul style="list-style-type: none"> • Recognizes the sounds of the instruments. • Creates and performs rhythm with the learned notes and duration values • Distinguishes the length and shortness of the sounds learned. • Performs melodies of different rhythmic structure. 	<ul style="list-style-type: none"> • Uses basic music texts and elements (Hex notes). • Performs melodies of different rhythmic structure. • Voices the notes learned. • It accompanies the music with its own rhythm pattern.
<u>7th Grade</u>	<u>8th Grade</u>
<ul style="list-style-type: none"> • It accompanies the music with its own rhythm pattern. • Distinguishes types of instruments and ensembles. • Creates sound and instrument groups 	<ul style="list-style-type: none"> • Performs melodies created by him/herself.
<u>Targets</u>	
<ul style="list-style-type: none"> • Increasing the student's interest in the subject and motivating him, • Keeping his attention alive, • Embody concepts and rules, • Simplifying concepts and topics. • Eliminating complexity and organizing information, • Easily present the relationship between concepts and information, • Ensuring order in the presentation and flow of information, • Ensuring the persistence of information. 	
<u>Tools and Equipment Used</u>	
<p>1 color cardboard, 1 adhesive, 1 Arduino Uno, 20 Jumper cables, 12 10Mohm Resistors, 12 Crocodile cables, 1 Dfplayer, 1 1 gb SD card, 2 buttons, 1 micro usb port, 1 8Ω-5W speaker, 1 2.5 headphone output</p>	

Connections were made according to the drawings given in Figure 4 (Circuit) and 5 (Schematic) using the tools given in Table 1.

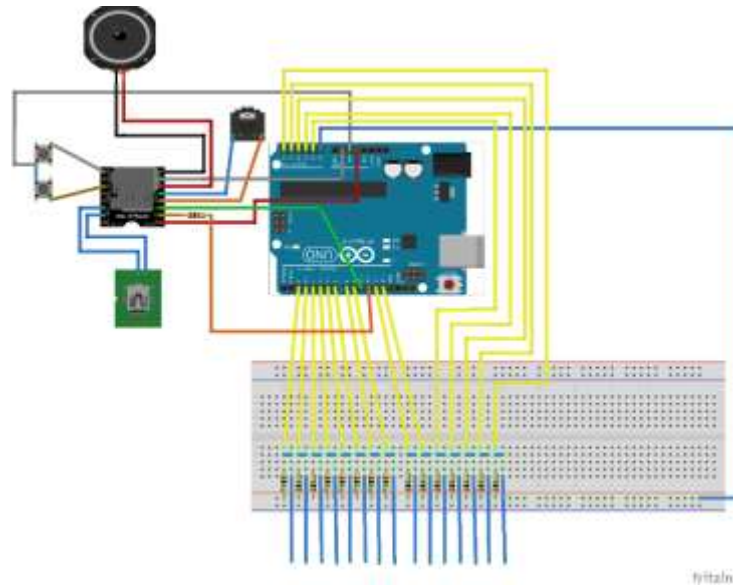


Figure 4. Touch music box circuit drawing

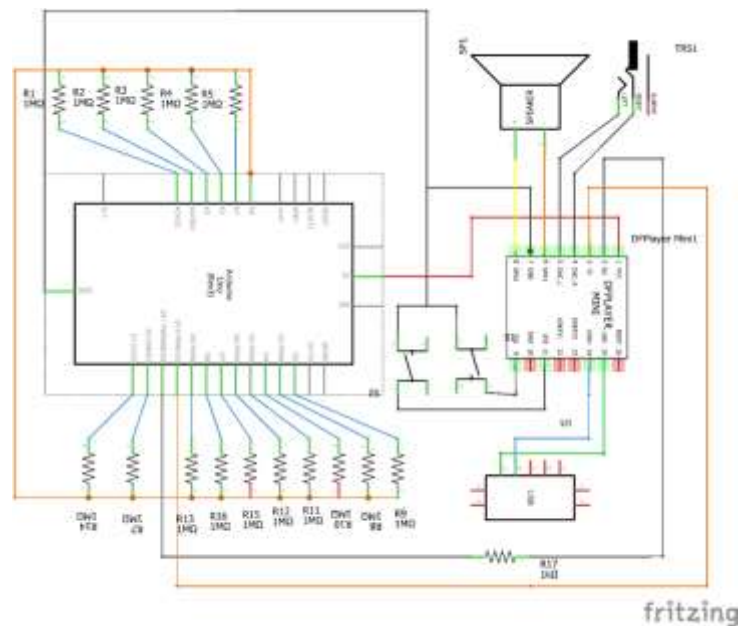


Figure 5. Touch music box schematic drawing

After the connections are made, the code in the internet address <https://drive.google.com/file/d/1RAC7gXNhBdT0XZEcTT378OsSWFAUo7c/view?usp=sharing> is loaded with the IDE compiler. The name of the audio files to be loaded into the SD card is “myDFPlayer.play (1);” must be loaded with the numbers indicated in parentheses with. Sound files assigned to the touches must be loaded in order to the SD card in order to trigger them in the correct order.



Figure 6. Touch music box

User instructions of the music box shown in Figure 6 are as follows. a. There are 15 crocodile cables. Tapping on the cable will trigger the sound file. b. It is micro usb connection. It is used for sending audio files into the SD card in the dfplayer module in the box. To start this connection, the power of the box must be supplied via a computer. c. The volume is adjusted. D. Headphone output. By connecting an external speaker, the volume can be increased.

Rhythm cards shown in Figure 7 have been created to be used with the music box. 8 rhythm cards were prepared by considering the achievements of Grade 5 that are “Creates and performs rhythm with the learned notes and duration values” and “Distinguishes the length and shortness of the sounds learned.”



Figure 7. Rhythm cards

According to the created rhythm cards, rhythmical mp3 files were created using music software and loaded on the SD card. The student is asked to match the cards by listening to the sound file triggered by the cable (s)he touched. Thus, it is thought that achievements can be reached with the purposes in Table 1.

Instrument cards that are prepared with the acquisition of Grade 5 “Recognizes the sounds of the instruments” are shown in Figure 8.



Figure 8. Instrument cards

According to the created instrument cards, mp3 files of the instruments are loaded on the SD card. The student is asked to match the cards by listening to the sound of the instrument triggered by the cable (s)he touched.

“Performs melodies created by him/herself.” (8th grade), “Voices the notes learned” (6th grade), “Performs melodies of different rhythmic structure” (5th and 6th grades), “Creates and performs rhythm with the learned notes and duration values” The efficiency of fruit instruments prepared by considering (5th grade) gains is shown in Figure 9. The sounds made from the fruits touched by crocodile cables contacted with the fruit. Thus, it is thought that learning will be made fun and interesting.

The note sounds of the desired instrument are loaded on the SD card. For example, the piano sound of the middle octave do sound should be loaded with the name specified in the mp3 file code. Otherwise, it will not read the file on the tapped cable because the device cannot find it.



Figure 9. Fruit instruments

The “piano floor mat” that was created for different uses of the touch music box is shown in Figure 10. It was created considering the gains determined for fruit instruments. Students can vocalize the sound of the piano or any musical instrument loaded in the music box with their feet. Thus, it is thought that the achievements determined and the objectives in Table 1 will be realized.



Figure 10. Piano floor mat

According to the colors of the notes, 20 * 30 cm size evas are lined up in sequence and the edges are covered with aluminum foil. The foils were sewed on the ground mat of 155 * 62 cm with conductive cables and numbered in the touchscreen music box. The sensitivity value of the touch music box is adjusted to the piano mat. Videos of touch music box <https://www.youtube.com/watch?v=VuuPTqvGTOY> (weighing cards), <https://www.youtube.com/watch?v=fPdBjiFtLps> (instrument cards), [https:// www.youtube.com/watch?v=UfQc8TTwiHM](https://www.youtube.com/watch?v=UfQc8TTwiHM) (fruit instruments) are located at.

Music Boards

Three music boards were prepared for teaching melodica and block flutes. The block flute board is designed as the main board and the side boards (melodica and music information board, exercise board) work connected with this board. Detailed information about the panels can be found in the X. International Hisarlı Ahmet Symposium proceedings book (2019, p. 354-368). The videos of the boards are located at https://www.youtube.com/watch?v=dGA_-Flc0mk

Touch Drum

In Table 2, touch drum gains and material list are given.

Table 2.

5, 6, 7 and 8th Grade Achievements of the Touch Drum and the Tools and Equipment Used

Achievements	
5th Grade	6th Grade
<ul style="list-style-type: none">• Performs the rhythm pattern created by himself.• Accompanies the music with its own rhythm pattern.	<ul style="list-style-type: none">• The sounds he learned were flute, melodica, etc. sings with instruments.• Accompanies melodies with its own rhythm pattern
7th Grade	8th Grade
<ul style="list-style-type: none">• Accompanies melodies with its own rhythm pattern.• Creates rhythm patterns consisting of different and repeated patterns.	<ul style="list-style-type: none">• Creates sound and instrument groups (melodica, block flute, etc.).• Creates rhythm patterns consisting of different and repeated motifs.

Targets

Increasing the student's interest in the subject and motivating,

- Keeping attention alive,
- Embody concepts and rules,
- Simplifying concepts and issues,
- Eliminating complexity and organizing information,
- Easily present the relationship between concepts and information,
- Ensuring order in the presentation and flow of information,
- Ensuring the persistence of information.

Tools and Equipment Used

2 (60 * 40 cm) duralite, 2 40 cm lath, 2 60 cm lath, 1 wooden glue, 1 Arduino Uno, 20 Jumper cable 1 mini breadboard, 8 10Mohm Resistor, Micro SD card module, 1 1GB SD card, 1 2.5 headphone output, 2 blue leds, 3 yellow leds, 3 red leds.

Connections should be made according to the drawings given using the tools and equipment given in Table 2 (Figure 11-12). Circuit and schematic drawings of the touch drum are given below.

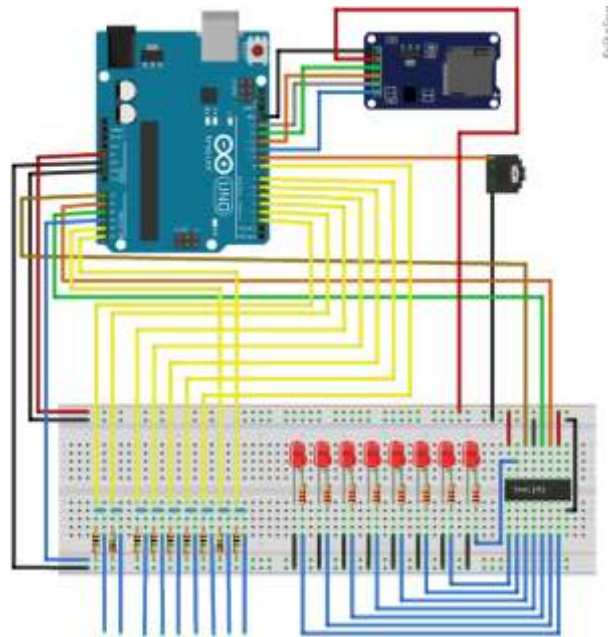


Figure 11. Touch drum circuit drawing

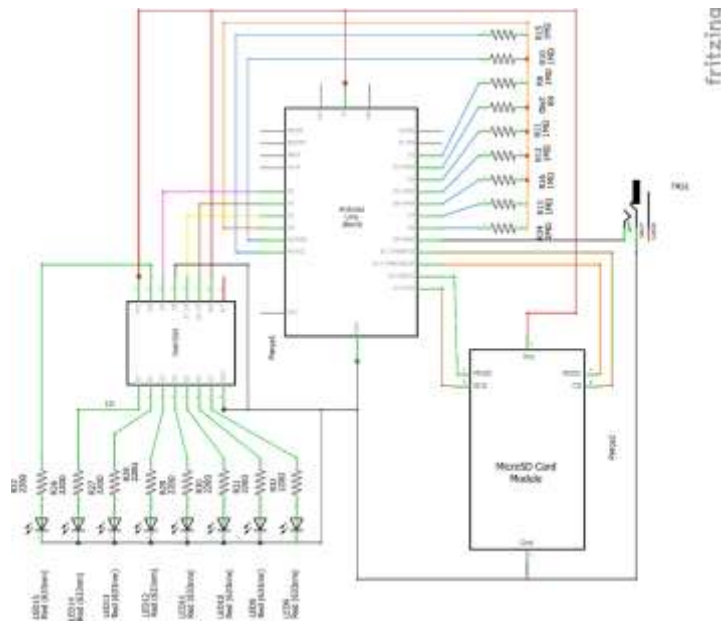


Figure 12. Touch drum schematic drawing

After the connections are made, Arduino Uno is loaded with the IDE compiler and the code located on https://drive.google.com/open?id=14ZDJ814sTcbQLPonRAa1_Nr8F3gjnILQ.

To trigger the sound files assigned to the touches in the correct order, the name of the sound files to be loaded into the SD card is must be loaded by “`tmrpcm.play (" A.wav ");`” taking into account the letters specified in parentheses.

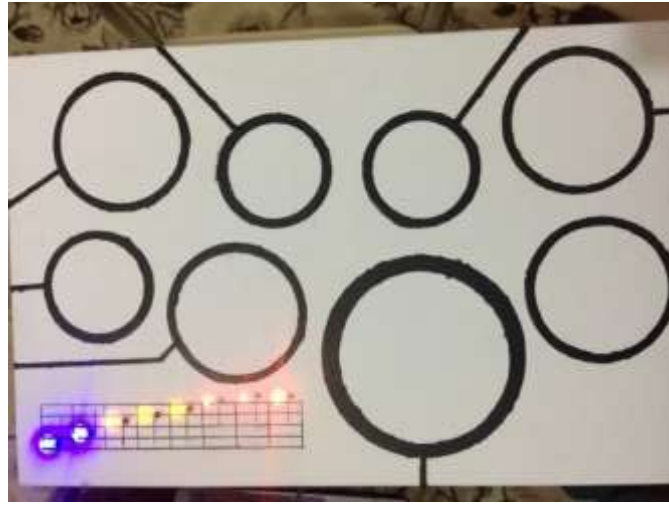


Figure 13. Conductive paint drawing

Circles are drawn with conductive paint on the 60 * 40 cm duralite as seen in Figure 13. Cable passages are provided by opening holes on the knee. Device “`tmrpcm.play (" BASLAT.wav ");`” is started with the command “Welcome to the touch drum”. The notes of the drum parts are shown on stave with leds.

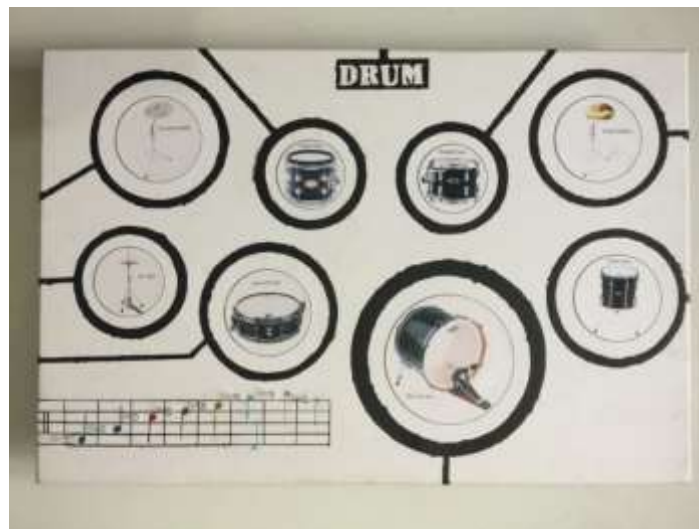


Figure 14. Touch drum

In Figure 14, bass drum, floor tom, snare drum, high tom, mid tom, ride cymbal, crash cymbal, hi-hat touch drum images were put into the circles. When the conductive paint on it is touched, the audio file of that image is played. Touching the "Drum" conductor gives voice information about drum types and acoustic properties. The related video of the touch drum is located at <https://www.youtube.com/watch?v=aZSzwO6LpyE>

Findings Related to the First Question

“Are the visual and audio materials designed using the Arduino platform prepared in accordance with the curriculum?” Findings related to the first question determined in the form are as follows:

When the data obtained from the interviews were examined, all of the music teachers were united in the idea that the materials were constructed in accordance with the secondary school music lesson program. In addition, the teachers stated that the materials were interesting and would make learning easier because they were concrete. Examples of the answers given by music teachers are presented below:

MT 1: Yes, it was prepared in accordance with the secondary school music lesson achievements.

MT 2: Yes, it definitely reflects the program, and it is easy to learn, as it is interesting and concrete.

The sixth music teacher also stated that the subject of basic music writing and elements is frequently covered in each class, especially in the 6th grade program, and the designed materials can be used here. The subject of basic music writing and elements takes place in all primary and secondary education levels. As a result, it is a common belief that the materials constructed can be used not only in the secondary school but also in primary and secondary education levels.

Findings Related to the Second Question

Results of the the second question of “Can the visual and audio materials designed using the Arduino platform be easily prepared and used by music teachers?” determined in the form are as follows:

Materials designs by music teachers' and the frequency of usage of the materials they designed in class

When the opinions of music teachers are analysed, we found out that two music teachers designed materials, two music teachers sometimes designed, one music teacher used IOS operating system applications, and the remaining five music teachers did not design any materials. Examples of the answers given by Music Teachers are presented below:

MT 1: I design material considering that it is necessary for the subject. The frequency of use varies according to the repetition of the subject and the level of comprehension of the students, I usually try to use materials in my lessons.

MT 2: I design but I make sure that it is simple and can be done together with students. I use the materials I designed for the subject I prepared.

Music teachers who designed materials generally stated that they designed materials in accordance with the subject and tried to use them in the lessons. It is stated that they try to ensure that the designed materials are simple and can be done together with students. Accordingly, students and teachers can realize their thoughts with Arduino in accordance with their level without difficulty. Thus, lasting learning with fun can be provided when designing materials. The sixth music teacher stated that he used the videos with the infrastructure he created through the IOS operating system applications. It is understood that this music teacher has information about music applications created for Android and IOS platform. Since the music teacher actively uses these applications in his lessons, he does not need any additional material design.

Support of the school management in providing materials and tools to music teachers

When the answers were analysed, we see that seven music teachers did not get any support from the school administration in terms of material and equipment supply, one received limited support and two received support from the school administration. Examples of answers given by music teachers are presented below:

MT 2: Piano, guitar, bağlama etc., which are the basic materials for music lesson. I contacted the school administration to get the instruments, but I did not get any positive responses. However, support is provided with limited budget for material preparation / design.

MT 3: No support, the argument is that there is no budget for this kind of stuff and it is reserved for other matters that have priority.

In general, music lesson is not considered as an important lesson by administrators, parents and students. As a result, it is generally said that there is no budget for those materials and equipments provision or that it is reserved for other matters that have priority and the idea of the teachers is that they are not supported in this regard. Since the music lesson is an application based lesson, when the required environment cannot be provided, the lessons cannot be effective by processing the lessons with theoretical and abstract concepts. Sixth music teacher; while he stated that he worked in many schools and was rarely supported; the first music teacher came up with the idea that the needs for the music lesson were not met in general. It is inevitable to get the support of the school administration in this regard. That is why the music teacher has a lot of duties. The music teacher should prove himself with selflessness and state that he wants to receive support from the administration after every successful job he accomplishes.

Ability of music teachers to prepare visual and audio materials designed using arduino platform

The first music teacher on the subject; While not as advanced as this, on a simpler level, he stated that he could prepare materials using the mBlock program, while the second music teacher stated that the price is not affordable and Arduino has a complex structure. The reason why the music teacher thinks so is estimated to be due to the lack of knowledge about Arduino and not taking any lessons on the subject. The third music teacher mentioned that there is a need for coding and design workshops in every school within the scope of the 2023 Vision, but she stated that there is not even a music class in the school she is working at and that there are not enough courses for teachers to receive in-service training. Accordingly, while the targets are being

expanded with the 2023 Vision, the lack of music classes in schools and the targets in line with this fact affect the music teacher's thoughts negatively. The fourth music teacher stated that the materials could be prepared if Arduino and coding courses were given to the music teachers by MEB (Ministry of National Education) within the scope of in-service training and the school provides financial support in this context. Arduino and coding training provided by MEB will be more useful if it is given not only to information technology and software teachers but also to all branch teachers. Sixth music teacher stated that teachers are not knowledgeable about the issue and many teachers do not even use the smart board in the lessons. Accordingly, it indicates that music teachers should also be provided with ready-made applications of Android supported IOS platforms and music technology training courses such as Cubase, Protools and Finale. While the eighth music teacher could not make a prediction, the remaining music teachers stated that they could design the materials. From here, it can be said that they are willing to prepare materials if sufficient information is provided and opportunities are provided to music teachers. Examples of the answers by music teachers are presented below:

MT 5: Yes. By providing interdisciplinary assistance, with the help of computer or vocational high school teachers, such materials can be prepared for use in classes.

MT 9: Yes, teachers can design with sufficient knowledge and opportunity.

The availability of the designed materials by teachers and students

All of the music teachers are united in the idea that the prepared materials can be easily used by teachers and students. Examples of answers given by music teachers are presented below:

MT 1: Yes, it can be used. I think students grow up with technology and teachers can easily use the materials.

MT 7: The designed materials can be used easily by teachers and students.

Moreover, the sixth music teacher stated that the designed materials may be more useful especially for primary school students because they are more curious and interested in these types of materials. Education provided to primary school children is focused on concrete learning, so the importance of material design is increasing in this period. Accordingly, it is thought that classroom teachers should also be trained in designing materials. In addition, the sixth music teacher stated that there should be music classes in schools to use such materials but most schools do not have music classes. It is imperative to have music classes in schools in order to protect the designed materials and use them easily by the students.

Findings Related to the Third Question

Findings related to the question of "Do the visual and audio materials designed using the Arduino platform make the music lessons more effective and affect student success?" Can be formed as follows:

Designed materials to make learning permanent

Music teachers are united in the idea that the materials will be effective in understanding the subject and providing permanent learning. While the third music teacher stated that using concrete materials for secondary school students would facilitate learning, the fifth music

teacher stated that these materials would make learning permanent with their features such as visibility, difference and sounds. It is thought that materials designed based on the ideas of music teachers will make learning permanent and will be more useful especially for primary and secondary school children. Examples of answers given by music teachers are presented below:

MT 1: As the materials are visual, auditory and concrete, they attract the attention of the student to make the learning easier and permanent. It provides permanent learning by facilitating practice and making learning entertaining.

MT 4: Using concrete materials for secondary school children makes learning easier and more permanent with such materials.

Effects of designed materials on student achievement

All of the music teachers stated that the designed materials will positively affect student success. Examples of answers given by music teachers are presented below:

MT 4: Using suitable materials for the subject may increase student success.

MT 5: Designed materials can increase student success as it provides exercise, question-answer method, and self-study.

In addition, while the first music teacher stated that the questions and the study board will be interesting for the students and that they can provide learning in the style of game among themselves; the second music teacher expresses that all the designed materials will positively affect the student achievement by attracting the students' attention and seeing and applying the abstract concepts of music. According to these interpretations, we found that students' success in music lessons will increase with the use of designed materials.

It is possible to use it for different gains by changing the mp3 files in the music box, which is one of the designed materials. Thus, it is thought that the lessons will be more entertaining in terms of variety of music.

Conclusion and Discussion

The importance of material-supported lessons is increasing day by day, and scientific studies on this subject indicate that material-supported lessons will have an impact on student success (Ördekci, 2016; Dalmışlı, 2013; Akarsu, 2007; Danış, 2007; Öztürk, 2004).

In this research, visual and audio materials that facilitate learning in music education were designed using the Arduino platform, and the designed materials were presented to the assessments of music teachers. In line with these assessments;

- The constructed materials for the secondary school music lesson program are suitable for the curriculum,

- Concerning material design, it was concluded that two music teachers designed materials, two music teachers sometimes designed, one music teacher used IOS operating system applications, and five music teachers did not design materials.

In his study where he investigated the effect of using material on student success, Akarsu (2007) emphasizes that the use of materials in primary school 6th grade music lessons is not sufficient. Dalmışlı (2013; p. 73), in her master's thesis on material development in music education, concludes that more information and skills can be provided to students with the help of materials and the use of materials always increases students' motivation. Introducing an abstract field such as music to the student, emphasizing the material design in such lessons with the idea that it will enrich the lesson and increase student success will both relieve the music teacher and provide permanent learning for the student. Therefore, it is concluded that material design should be included in the music lessons besides the use of materials.

Regarding the subject, Leyla Küçükahmet (2005; p. 115) states that some teachers are afraid of using even a simple tool in their hands. One of the reasons is that the teacher does not know how to use that tool. Uçar (1999; p. 196) emphasizes that education should be based on the latest educational technology and appropriate tools. When the studies of Gürman (2019) and Dalmışlı (2013) are examined, they conclude that MEB does not provide in-service seminars on the preparation and use of materials for teachers. Besides, music teachers cannot participate in seminars with technological support (Gürman, 2019). In this regard, in order to inform teachers about new teaching technologies and to enable them to develop materials suitable for their lessons, they should be supported by in-service training activities both in teacher training institutions and in the system (Güven, 2006).

Besides, in the research we found that;

- It has been revealed that music teachers generally do not get support from school management regarding the supply of equipment,
- Some music teachers stated the idea that it would be possible to prepare the designed materials by teachers, while some music teachers stated that it was not possible.

Asan (2002; p. 218) states that there are few educated teachers who can use the technology in the class, many teachers do not know how to use the computer and therefore cannot fully use it in the class. In order for teachers to use new technologies in the classroom, they need to follow the technology and renew themselves on the subject. Nowadays, classes such as smart class (Smart Class) and future technology class (Hyper Class) are mentioned, which eliminate the problem of space and distance and equipped with all the tools of technology (Güven, 2006). Ulusoy and Gülüm (2009) draw attention to the fact that in-service courses should be conducted widely in order to provide teachers with information on how to use technological developments and how to use various materials, as countries have to train teachers and students who keep up with developing technology.

In this period when technology is highly progressive and different technological products enter our lives every day; teachers need to develop themselves in this direction and develop different materials and take steps towards becoming future educators. Ultimately, the biggest responsibility for the use of educational tools at school falls to the teacher.

Moreover;

- The designed materials can be easily used by students and music teachers,
- It has been concluded that the materials will be effective in making students understand the subject and receive permanent learning, making learning permanent by playing games, interesting materials, providing the opportunity to work and exercise individually, offering the opportunity to do by applying and seeing abstract concepts and positively affect student success.

In his study, Danış (2007) stated that a course enriched with visual materials will be interesting, it will save the course from monotony and focus, and the lessons will become more meaningful and permanent, while Ördেকci (2016; p. 62) regarding the use of visual materials in music education, stated that classroom and music teachers draw attention in a course supported with visual materials, when the subject is integrated and integrated with the visual, the student understands the subject better and provides permanent learning.

All these views emphasize the importance of visual and audio materials in education and the question of how essential materials are in secondary school education.

As a result, it is thought that the materials used in accordance with the subject at the primary level, which is the concrete process period and in the music lesson with abstract concepts as content, will support both the teacher and the teaching.

Implications

It is recommended that;

- Preparing the materials for primary and secondary school students according to their class outcomes,
- During the preparation of the materials, to seek help or collaborate with experts from different fields (art teacher, music teacher, computer teacher, vocational high school teachers, etc.),
- Increasing the support of school management to music teachers for material design,
- These materials are included in the teacher's manual prepared by the Ministry of National Education for primary and secondary schools,
- MEB has increased the in-service seminars about Arduino and no branch distinction in these seminars,
- Add the Arduino topic to the courses related to designing material in the university curriculum.

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