STEAM based music activity example for gifted students: I design my instrument with Scratch and Makey Makey

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In this study, the aim is to present a STEAM-based music activity for gifted students and to determine the students' awareness of the process at the end of the activity. The study group of the research consists of exceptionally gifted students who applied to STEAM Based Music Activities Workshop in the Halil İnalcık Science and Art Center. Accordingly, we determined the study group of the research as 25 5th grade students studying at Bursa Halil İnalcık Science and Art Centre in the 2023–2024 academic year. At the same time, these students also take information technologies course. We carried out the activity of "I design my instrument with Scratch program and Makey Makey" for a total of 8 hours in 4 weeks, i.e., two hours each week. The activity was prepared in line with the 5E learning model. At the end of the research, we applied the Formative Evaluation Form to the students and obtained data about their awareness of the process. We used the content analysis method to analyze the date. In the research, we determined that the students enjoyed the activity, their interest in music increased, music can be used effectively in different fields, coding studies with music are more fun, and they developed self-confidence by liking their work. In line with the data obtained in the research, the conclusion was that the realisation of music lessons with different fields by using today's technologies has positive effects on students.

Keywords: STEAM education, technology, gifted student, coding, 5E learning model

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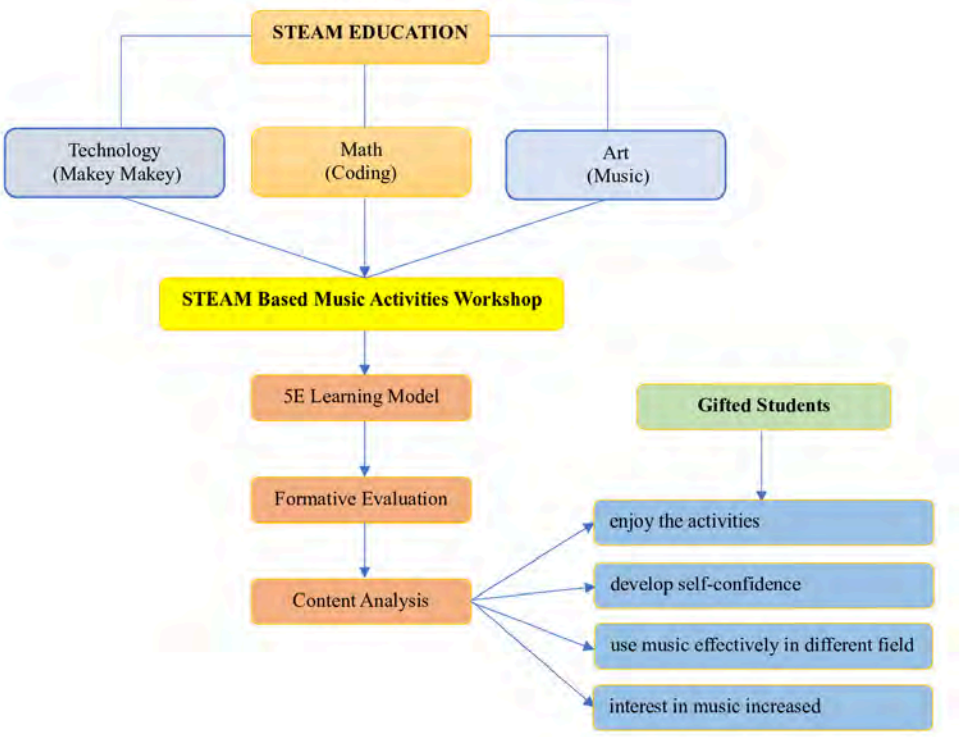

1 Introduction

The expectations and needs of individuals change depending on social, economic, technological and political developments in each period (Cansoy, 2018). Researchers have been concentrating on the question of how education and training should be structured to enable individuals to effectively adjust to advancements in specific fields (Karslı Baydere et al., 2019). There's also a belief that contemporary teaching methods should provide benefits that align with present-day requirements (Phanichraksaphong & Tsai, 2021). It is known that course contents designed around a single discipline are not sufficient to increase the quality of education and to provide more permanent learning. Especially today, as we enter the fourth industrial revolution, the interdisciplinary approach is thought to be more important than ever (Jesionkowska et al., 2020).

The STEAM approach, created with the understanding of interdisciplinary education, aims to use more than one of the fields of science, technology, engineering, art and mathematics. For this purpose, there are many studies showing that interdisciplinary studies improve students' 21st century skills. (Aguilera & Ortiz-Revilla, 2021; Singh, 2021; Liao et al., 2016; Ridwan et al., 2021; Zayyinah et al., 2022; Taylor, 2015; Allina, 2017)

The STEAM approach first emerged as STEM apart from the art dimension. However, the “art” dimension was also integrated into the approach, with the thought that these four disciplines could not fully meet the needs of the students (Mercin, 2019). STEAM education combines the arts with traditional STEM fields so that different disciplines can expand and inform each other (Barnes et al., 2019). By adding the art dimension to the related approach, students can create rich educational environments on the axis of design and creativity, such as finding effective solutions to current problems, producing projects and designing useful products from these projects (Erdoğan, 2020). Albert Einstein said, “If I wasn't a physicist, I would probably be a musician. I often think with music. I live my dreams with music. I see my life in terms of music.” This is a good example showing that art should be included as an indispensable element in the STEAM approach (Ramsey, 2022).

The use of the STEAM approach in the education of gifted students is important (Barış & Ecevit, 2019). Many STEAM-based studies developed for gifted students also demonstrate the importance of STEAM approach in education (Paik, 2013; Wilson, 2018; Mullet et al., 2017; Kanlı & Özyaprak, 2015; Ülger & Çepni, 2020; Robinson et

al., 2014; Root-Bernstein, 2015; Özçelik & Akgündüz, 2017; Vu et al., 2019). Coding education is also used in STEAM activities prepared for gifted students.

Coding education has an important role in the STEAM approach. With coding, studies can be carried out in many different areas. Miller (2019) defined coding as a language that makes use of a set of syntax rules (or blocks for elementary school students) that inform a computer program to perform a set of functions. In other words, coding education is the use of programming languages in order to achieve the determined goal (Çepni, 2018).

There are programs that enable creating music through coding and can be used effectively in music education. One of these programs, Sonic Pi, is a free web application where users can work on creating and displaying code-based music. Petrie (2022a) tried to find out how the Sonic Pi program affected students' attitudes towards programming, and he conducted a case study for secondary school students. In general, the results showed that all sub-dimensions of the students' programming attitudes, including enjoyment, importance and anxiety, increased significantly in a positive direction. In a different study, Petrie (2022b) examined how the Sonic Pi application would support learning outcomes in both music and programming in order to support Computational Thinking integrated into the Technology learning area of the New Zealand School curriculum. The results show that educators can use Sonic Pi to support many learning outcomes in the field of music and programming.

One of the tools used in this study is Scratch. Scratch, another coding program, has been widely used in education in recent years. Scratch provides a music module to enable children to create the music they want in their projects with the help of coding and to express their emotions freely (Gao et al., 2020). Scratch has the ability to generate and play sounds using components from different sound categories (Ruthmann et al., 2010). Figure 1 shows the music activity interface of the Scratch program.

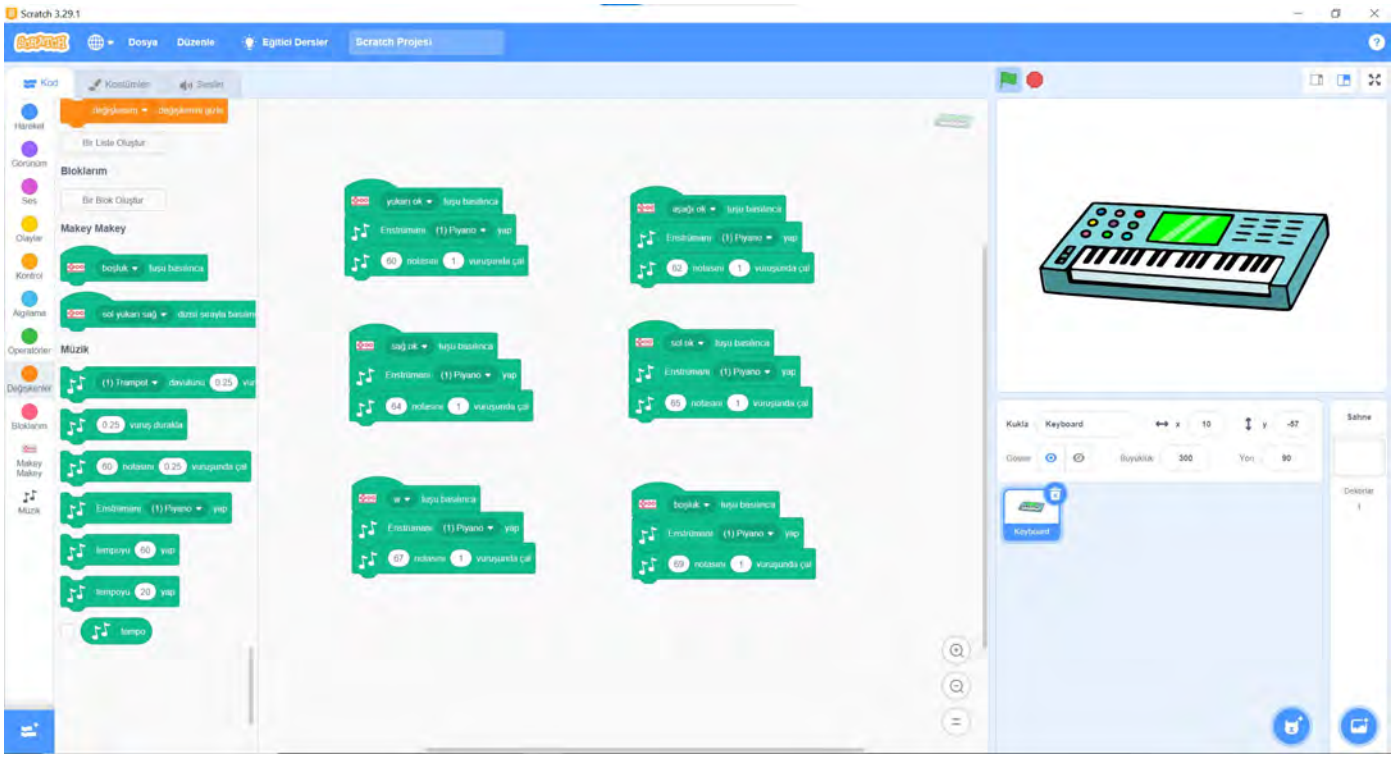

Figure 1. Scratch music program interface

Another tool used in this study is Makey Makey electronic kit. Primary school students may have difficulty in understanding concepts related to electricity. On the other hand, concrete user interfaces such as Makey-Makey are an interesting alternative for teaching this subject (Fokides & Papoutsi, 2019). With the Makey Makey electronic kit, conductive objects can be turned into touch surfaces. This approach ensures that students not only grasp the fundamentals of basic electronic circuits but also engage in these activities with enthusiasm (Tanık Önal & Ardıç, 2020). In addition, technological integration in education has become an inevitable part of an ever-changing world. This situation makes it necessary to use technological tools in education (Islam Sarker ve diğerleri, 2019).

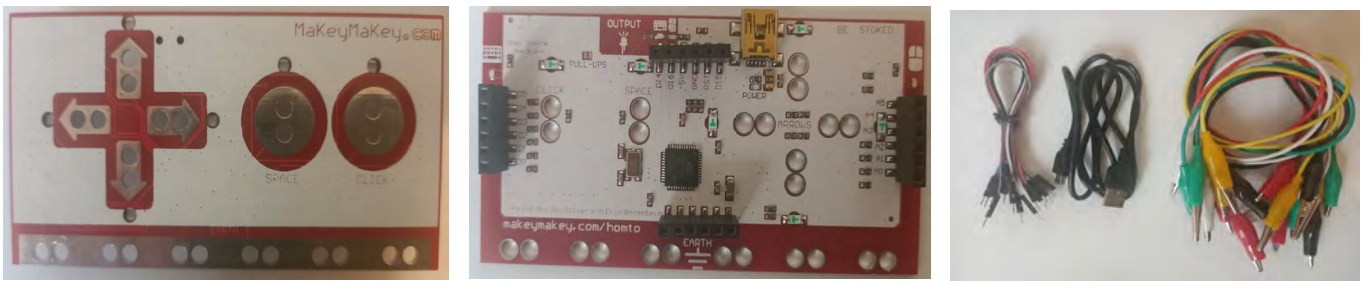

Figure 2. Parts of Makey Makey electronic kit

In Figure 2, the parts of the Makey Makey electronic kit are presented. First, this technological resource consists of several components. A USB port is located on the front for easy connection to a computer. This part has the necessary tools to control the device interactively. In the back part, there is a motherboard next to the processor based on the Arduino programming language. On the other side, there are wiring and control clips that connect to various slots both front and back. To interact with other everyday objects, Makey Makey components include actuators, sensors and a processor as a logical part of the device **(**Marin-Marin et al., 2020).

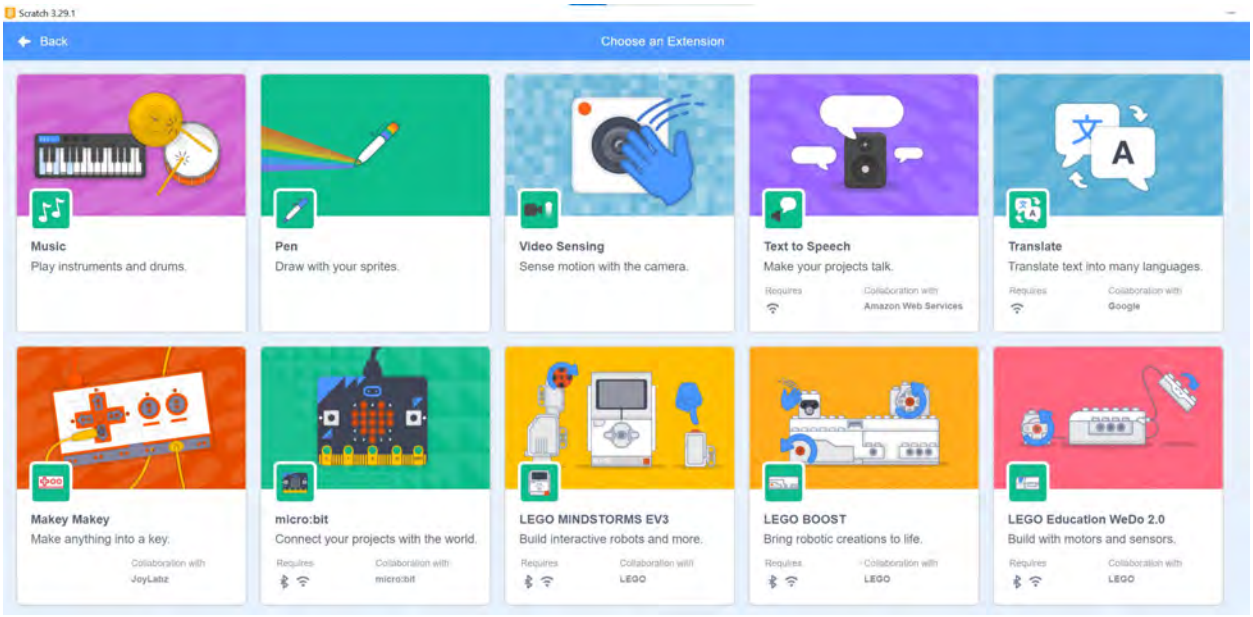

Figure 3. Scratch program add-ons

Figure 3 shows the tools in the add-ons section of the Scratch program. When students want to make music studies in the Scratch program with the help of Makey Makey Electronic Kit, they should select the relevant plug-ins (Music and Makey Makey) and add them to the code blocks.

Figure 4 shows music coding blocks in the Scratch program. There are three blocks of add-ons. Different blocks can be added to the program depending on the purpose of the study. At the top of the blocks, one can see which of these sections on the Makey Makey Electronic Card (Figure 2) will be connected to. The instrument selection block is in the middle, and the notes and note values block is at the bottom. Students first design a musical work that they can perform with Makey Makey in the Scratch program, and then connect Makey Makey, Scratch and conductive materials. Students participate in music making through a tactile design by connecting conductive objects

to Makey Makey (crocodile clips) instead of the computer keyboard (Chen & Lo, 2019).

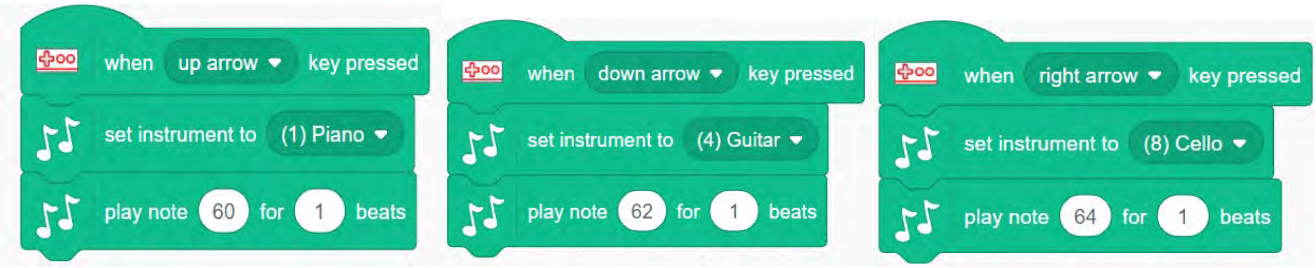

Figure 4. Scratch program music code blocks

In the activity design of the research, we used the 5E Learning Model consisting of engage, explore, explain, elaborate and evaluate stages. The 5E Learning Model is considered significant in the STEAM approach as it helps structure the STEAM disciplines, enabling students to establish connections between them and integrate their experiences into their daily lives (Çepni, 2018). In Table 1, the stages of the 5E learning model are given together with their explanations.

Table 1. Stages of the 5E learning model

Stages	Contents of the stages
Engage	In the engage stage of the model, the aim is to involve students in the learning process. For this purpose, students are asked to think critically by brainstorming about the subject (Hew et al., 2020).
Explore	In the explore stage of the model, students can begin to investigate the topic with the introduced materials and concepts. Students can discuss their ideas in groups with other students and relate what they have learnt previously to this new idea. In this way, the teacher will be able to assess how much knowledge the students have about the topic (Hassan et al., 2019).
Explain	In the explain stage, students construct meaning from the experiences in the previous stages. The teacher directly clarifies concepts, practices and skills related to STEAM disciplines. Questions from the teacher or other sources can lead students to a deeper understanding of the STEAM disciplines, which is the most critical part of this phase (Bybee, 2019).
Elaborate	In the elaborate stage, students are provided with new situations that challenge them in relation to what they have learnt in the previous stages of the lesson. Although this stage precedes the formal assessment of students' learning, it can also be considered as an extension of the clarification stage (Turan & Matterson, 2021).
Evaluate	In the evaluate stage, students should receive feedback about their work. The teacher can obtain feedback from assessment tools such as self-assessment, teacher observation, performance assessment, portfolio and rubric (Çepni, 2018).

The literature review revealed that there is a scarcity of STEAM studies in music education in Turkey. Particularly in this digital age, it is believed that such studies are crucial in the realm of music education. Moreover, coding education holds significance in Science and Art Centers that offer activity-based learning for gifted students. Conducting coding-based projects within music activities at these centers is seen as a way to enhance the STEAM approach in the field of art.

At the same time, many researchers have examined the use of music and accompanying technology as a tool to increase interest in science (Gregorio et al., 2015; Dorfman, 2022; Gorbunova & Hiner, 2019; Waddell & Williamon, 2019; Alekseenko & Rakich, 2020; Liu, 2019; Potapchuk et al., 2021). Coding education is important for students to develop problem solving, analytical thinking, creative thinking and computer literacy. However, learning coding can be perceived as a difficult task as it requires a certain abstraction skill that primary school students have not yet developed. To address this challenge, abstract programming concepts such as variables and parameters can be effectively conveyed to students by programming songs, offering a more tangible and concrete approach to learning (Lavy, 2021).

In the current research, we aimed to present an activity example that can be applied within the scope of "STEAM Based Music Activities" for gifted students in general abilities. We explored how gifted students experienced and perceived the process of STEAM-based music activities. The research problem can be framed as, "What is the process involved in creating and executing an example of a STEAM-based music activity?" In the context of the "I design my instrument with Scratch and Makey Makey" activity for exceptionally talented students, the aim was to answer the following questions:

A. How did their ideas evolve?
B. What observations did they make?
C. What situations or discoveries surprised them during the process?

2 Method

2.1 Research model

In this study, we introduced a STEAM-based music activity and conducted assessments to determine the level of awareness it generated in the students upon completion. To achieve this, we employed the case study method, which enables researchers

to gather comprehensive information using various data sources over a specific timeframe and to describe the gathered insights in detail (Creswell, 2007).

Case study offers various benefits to the researcher in terms of process and outcome. It helps the researcher to focus on a specific situation within the boundaries of time and space, giving the chance to look in depth at the inner workings and interactions of the current situation or individual (Burkholder et al., 2019).

2.2 Study group of the research

The study group was selected through criterion sampling, which is one of the purposive sampling methods. Purposive sampling is commonly employed in research to identify and select cases that provide rich information relevant to the phenomenon under investigation. Among the various purposive sampling strategies, criterion sampling, as noted by Palinkas et al. (2015), is one of the most frequently applied methods in practical research. According to Patton (1980), purposeful sampling enables in-depth examination of situations believed to offer valuable information.

Criterion sampling, a purposive sampling method, involves studying all situations that meet a set of predetermined criteria. These criteria can be established by the researcher or drawn from a pre-existing list of criteria (Şimşek and Yıldırım, 2011).

In this research, the limited number of exceptionally talented music students at the Science and Art Centre where the study was conducted necessitated the inclusion of general talent students in the sampling group. Science and Art Centers can hold workshops for exceptionally talented students in different fields. The study group of the research consisted of students who applied to the "STEAM-Based Music Activities" workshop based on the determined criteria.

The criteria used to select the research group were as follows:

1. Students must be enrolled at the Science and Art Centre where the research is conducted, and their attendance must be compulsory.
2. Students must have an interest in music, willingly participate in the study, and have obtained parental approval.
3. Students must be at the secondary school level (aged between 10 and 11).

Upon evaluating student practices for the "STEAM-Based Music Activities" workshop, it was noted that the highest participation came from 5th-grade students. Subsequently, a review of the curriculum for 5th-grade students attending Science and Art Centers revealed that they also had took information technologies and

mathematics courses. This finding strengthens the suitability of the selected group for interdisciplinary studies.

The study group of this research is 25 5th grade students studying in the field of general ability at Bursa Halil İnalcık Science and Art Center in the 2022–2023 academic year. The study group consisted of students who enrolled in the "STEAM-Based Music Activities" workshop and took information technologies course at the same center. The study group consisted of 14 female and 11 male students. Within the scope of the study, parents were informed and necessary permissions were obtained.

2.3 Data collection instruments of the research

In this study, we presented a STEAM-based music activity. At the end of the activity, formative evaluation was conducted to assess the students' awareness of the process. Formative assessment is frequently utilized to provide on-going feedback with the goal of enhancing teaching and learning within the classroom (Hargreaves, 2005). Formative assessment also has the potential to support teaching and learning in the classroom (Schildkamp et al., 2020). Data for formative assessment can be gathered through questioning and discussions with students, by reviewing their work, or by directly observing students as they engage in their tasks (Brookhart, 2010).

Another way to understand formative assessment is to compare it with summative assessment. Summative assessment focuses solely on recording current student achievement. Formative assessment, on the other hand, is used to provide feedback from students regarding the subject and process and to identify and implement instructional corrections. It is accomplished through open-ended questions or observations directed at students while teaching or reviewing content. If the information obtained from observations and questions directed to students is accurate, the teacher can determine instructional adjustments that can help improve student learning. In this way, formative assessment and instruction are integrated, ideally resulting in a seamless process of assessment, instruction, and then further assessment (Cauley & McMillan, 2010).

Formative assessment can be used for different purposes. One of these is that it allows students to evaluate themselves. When giving feedback, teachers encourage them to evaluate themselves by asking questions such as "What do you think about how well you learned?" (McTighe & O'Connor, 2005). In the current research, we prepared a "Formative Evaluation Form" by taking expert opinion in order to assess the awareness of exceptionally talented students regarding the activity process. In the

form, we asked 3 questions that the students could answer easily, considering their age groups. “Formative Evaluation Form” is given in Table 2.

Table 2. Formative evaluation form

Scratch program and Makey Makey kit for designing my instrument activity;
My opinions that have changed:
Things I have noticed:
Situations that surprised me:

2.4 Data analysis method of the research

In this study, we analyzed the data obtained with the formative evaluation form used to assess the students' awareness at the end of the activity using the content analysis method.

Content analysis is one of the most important analysis methods used in social sciences. In content analysis, researchers focus on providing a simple but in-depth report on commonalities and differences in the data (Vaismoradi & Snelgrove, 2019). This method of analysis recognizes that societies are animated by speeches, texts and other forms of communication and that it is impossible to understand social phenomena without understanding how language functions in the social world (Krippendorff, 2018). When the data allow for the interpretation of hidden content, qualitative content analysis reveals both depth and meaning in participants' statements (Lindgren et al., 2020). Table 3 presents the themes and codes derived from data gathered from the students through the Formative Evaluation Form.

Table 3. Themes and codes created through students' opinions about the activity

Theme	Code	Students
My opinions that have changed	Instrument design	S1, S2, S17
	Coding and music	S2, S4, S5, S6, S14, S25
	Fun and learning	S3, S6, S7, S8, S11, S13, S18, S21, S25
	Changing prejudices	S1, S2, S4, S5, S7, S12, S14, S15, S16, S17, S18, S21, S24
	Gain new information	S19
	Universality of music	S9
	Increasing interest in music	S10, S12, S21, S22
	Evaluating school music lessons	S20, S23
Things I have noticed	Development of creativity	S1, S9
	Enjoying the activity	S2, S3, S4, S12, S14, S20, S22, S24
	Potential of the Scratch program	S5, S10, S13, S16, S18, S21, S25
	Makey Makey Kit and music relationship	S23
	Development of coding skills	S7, S15
	Understanding the relationship of music in different fields	S6, S11
	Self-confidence development	S8, S17, S19
Situations that surprised me	The combination of technology and music	S2, S7, S9, S12, S15, S16
	Using the Makey Makey Kit	S1, S3, S5, S12, S13, S18, S21, S22, S23
	Creativity and success	S6, S14, S20
	Recognizing conductive materials	S11, S13, S17, S19, S23, S24, S25
	Coding and entertainment	S8
	Instrument design from recycled materials	S4, S10

Table 3 includes the codes generated with the guidance of expert opinion, based on the data collected under the themes of "my changing ideas," "things I noticed" and "situations that surprised me" for the "I design my instrument with Scratch and Makey Makey" activity among exceptionally gifted students. In this study, 22 codes were created under 3 themes. In the reliability phase of the created codes, the result of agreement between the experts examining the codes (Reliability = Number of agreement / (Agreement + number of disagreement)) is expected to be higher than 70% (Tavşancıl & Aslan, 2001). In this regard, three experts reviewed the codes generated by three researchers. All the consulted experts confirmed that the identified codes aligned with the content. We subsequently presented and analyzed the data collected via the Formative Evaluation Form in tables within the findings.

2.5 Implementation of the activity

In this part of the study, we presented the design of the activity according to the 5E model and practices at each stage. We carried out the activity for a total of 8 hours, 2 hours per week. The duration of this period was determined based on the practices to

be conducted in the activity.

2.5.1 Engage

The students were introduced to the idea that music can interact with various disciplines and can be applied effectively in diverse fields. They received a brief overview of the planned activities within this context. At this point, we asked the students about their familiarity with the Scratch program, and addressed any fundamental gaps in their knowledge of the program. Furthermore, we informed the students that they could also conduct music-related projects using this program and encouraged them to brainstorm and discuss potential studies in groups.

In the activity, the Scratch program requires basic student experience. Students take the Information Technologies course at the same center and work on the Scratch program in this course. As a result, the students have prior knowledge about the relevant program.

2.5.2 Explore

At this stage of the activity, the students learned that they could also make music with the help of coding. We informed students that the Scratch program would be used for music design and introduced the parts of the program related to music design. Then, the students carried out basic level activities. At this stage, the students vocalized the “Harry Potter” music by coding it in the Scratch program with the teacher. Thus, students are assumed to have learned basic notes and note values through coding in the program. After the music coding activities with the students, we introduced Makey Makey Electronic Kit. We presented the connection between Makey Makey Electronic Kit and Scratch to the students with two different setups set up by the teacher. The students were allowed to experience the set up. At this stage, we carried out two studies with the students. The first of these studies is the vocalization of a note sequence (C Major Scale) coded in the Scratch program, through glasses filled with water and bananas, with the help of the Makey Makey Electronic Kit. Figure 3 displays images of the engage and explore phases.

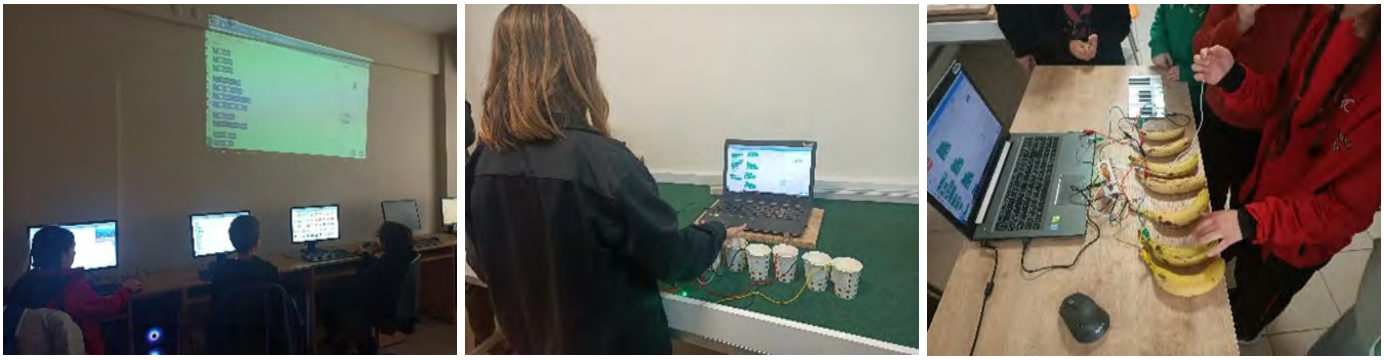

Figure 5. Images of the engage and explore stages

2.5.3 Explain

At this stage, the aim was for the students to produce new information by utilizing their previous experiences. For this reason, the students were given an octave piano keyboard model and asked to code it in Scratch program and then vocalize it with Makey Makey Electronic Kit. Figure 4 displays images related to the explanation stage.

Figure 6. Images of the explain stage

2.5.4 Elaborate

At this stage, we asked students to make different instruments with the recycled materials brought to the classroom. They could use the available materials as much as they wanted. In addition, they were expected to code using the sound effects they wanted in the Scratch program and make sounds using the Makey Makey electronic kit. Figure 5 displays images related to the elaborate stage.

Figure 7. Images of the elaborate stage

2.5.5 Evaluate

In the evaluation phase of the activity, the aim was to assess the students' awareness of the process. In this context, the data obtained from the students' Formative Evaluation form at the end of the activity are presented in the findings.

3 Findings

In this part, we evaluated the data obtained from the Formative Assessment Form in line with the content analysis applied to the students at the end of the activity and we presented these data in tables. While creating the tables, we coded the students as given in the "Student" column.

Table 4. Codes that were created under the theme of "My opinions that have changed"

Theme	Code	Students
My opinions that have changed	Instrument design	S1, S2, S17
	Coding and music	S2, S4, S5, S6, S14, S25
	Fun and learning	S3, S6, S7, S8, S11, S13, S18, S21, S25
	Changing prejudices	S1, S2, S4, S5, S7, S12, S14, S15, S16, S17, S18, S21, S24
	Gain new information	S19
	Universality of music	S9
	Increasing interest in music	S10, S12, S21, S22
	Evaluating school music lessons	S20, S23

Table 4 contains the codes obtained through the students' opinions about the theme of "my changing ideas" in the Scientific Evaluation Form. In this regard, we created 8 codes under the theme of My Changing Ideas. Table 4 and Table 5 were evaluated together.

Table 5. Findings obtained under the theme of "My opinions that have changed"

Student	Student opinions
S1	I never thought I could design a musical instrument, but now I can.
S2	At first, I didn't believe that I could make a musical instrument sound with coding, but now I can.
S3	Music lessons with the computer are a lot of fun.
S4	I thought the combination of coding and music would be difficult, but it wasn't.
S5	I didn't like the works I did in Scratch program before, but I found my music works very successful now.
S6	I learnt things I didn't know about music and coding and these activities were a lot of fun.
S7	I didn't have much interest in music before, but now I like it more.
S8	It was fun to make music with coding.
S9	I learnt that music can be used everywhere.
S10	I started to like music more.
S11	Computer and music lessons are a lot of fun together.
S12	Before this class I was not very excited about music. But this class showed me the fun side of music and gave me new ideas. Now I look forward to taking this class.
S13	I learnt that music can be made in Scratch.
S14	I think Scratch program is not boring anymore.
S15	I found coding a bit boring, but I was very interested in doing music activities with coding.
S16	I thought coding was boring and difficult, but it was both easy and fun.
S17	I was not interested in musical instruments before, but I am interested in them now. I even got a musical instrument and started playing it.
S18	Normally I don't like music, but now I think it is more fun. Especially coding music is very fun.
S19	Before coming to this workshop, I never thought that we could make music with bananas and water.
S20	I think that this is how music lessons should be organized in our schools.
S21	I used to not enjoy music lessons much, but now I do.
S22	I became more interested in music lessons.
S23	I was quite bored with the music lessons in our school. With such activities, music became more enjoyable.
S24	I was prejudiced about the activity to be carried out beforehand, but I really liked the work carried out over time.
S25	Now I think coding is more fun thanks to music.

Table 4 presents the codes we created from the student opinions given in Table 5. Under the theme of "My changing ideas" during the process of the activity; 3 students stated their opinions on instrument design, 6 students on coding and music, 9 students on entertainment and learning, 13 students on changing prejudices, 1 student on acquiring new information, 1 student on the universality of music, 4 students on increasing interest in music, and 2 students on school music lessons. When we evaluate student opinions in general, we see that the issues that many students approached with prejudice before the activity changed positively afterwards. In this case, the

activity increased students' awareness and developed positive thoughts in them. Table 5 displays student opinions in detail.

Table 6. Codes that were created under the theme of "Things I have noticed"

Theme	Codes	Students
Things I have noticed	Development of creativity	S1, S9
	Enjoying the activity	S2, S3, S4, S12, S14, S20, S22, S24
	Potential of the Scratch program	S5, S10, S13, S16, S18, S21, S25
	Makey Makey Kit and music relationship	S23
	Development of coding skills	S7, S15
	Understanding the relationship of music in different fields	S6, S11
	Self-confidence development	S8, S17, S19

Table 6 contains the codes obtained through the students' opinions about the theme of "Things I noticed" in the Scientific Evaluation Form. We created 7 codes under the theme of "Things I noticed". Table 6 and Table 7 were evaluated together.

Table 7. Findings obtained under the theme of "things I have noticed"

Student	Student opinions
S1	I have noticed that my creativity has improved. I couldn't think of such things before.
S2	I have noticed that I love designing musical instruments.
S3	I have noticed that I really enjoyed making a musical instrument and being able to play it by coding it in the Scratch program.
S4	I have noticed that making music through coding is a lot of fun.
S5	There are so many things I can do with the Scratch program.
S6	I have noticed that music can be used in different fields.
S7	I also improved in coding and music.
S8	I thought I was bad at music, but I'm not.
S9	I have noticed that I could design new things even if I had difficulties.
S10	I have noticed that programs such as Scratch can be used for different purposes with Makey Makey.
S11	Music can be made with information. Music can be made with conductive materials.
S12	I have noticed that I enjoy designing different things with music activities.
S13	I have noticed that you can play beautiful music with Scratch by using new blocks.
S14	I have noticed that I like this kind of music events.
S15	I have noticed that my coding skills improved, and I learnt new things.
S16	I have noticed that I could make music with coding in the Scratch program.
S17	I have noticed that I have an interest in music and even a little talent for it.
S18	I have noticed that there were many things I didn't know in Scratch and I was very happy to learn them.
S19	I have noticed that I had a little talent for music.
S20	I have noticed that I really like music events that take place in this way.
S21	I have noticed that there is a code part in the Scratch program that can make music.

S22	I have noticed the music was a lot of fun.
S23	I have noticed that Makey Makey electronic kits can be used to make music.
S24	I have noticed that music is even more fun thanks to the events we organized.
S25	I have noticed that scratch can be used for different purposes.

Table 6 presents the codes created from the student opinions given in Table 7. Under the theme of "Things I noticed" regarding the activity process; 2 students expressed their opinions on the development of creativity, 8 students on enjoying the activity, 7 students on the potential of the Scratch program, 1 student on the relationship between Makey Makey Kit and music, 2 students on the development of coding skills, 2 students on understanding the relationship of music in different fields, and 3 students on developing self-confidence. Most of the students enjoyed the activity and discovered the potential of the Scratch program. Students also work on the Scratch program in Information Technologies Classes. In this activity, students experienced that the Scratch program can also be used in music education. In this way, students became aware of a relationship between music and technology.

Table 8. Codes that were created under the theme of "Situations that surprised me"

Theme	Codes	Students
Situations that surprised me	The combination of technology and music	S2, S7, S9, S12, S15, S16
	Using the Makey Makey Kit	S1, S3, S5, S12, S13, S18, S21, S22, S23
	Creativity and success	S6, S14, S20
	Recognizing conductive materials	S11, S13, S17, S19, S23, S24, S25
	Coding and entertainment	S8
	Instrument design from recycled materials	S4, S10

Table 8 contains the codes obtained through the opinions of the students for the theme of "Situations that surprised me" in the Scientific Evaluation Form. We created 6 codes under the theme of "Situations that surprised me". Table 8 and Table 9 were evaluated together.

Table 9. Findings obtained under the title of "situations that surprised me"

Student	Student opinions
S1	I was surprised that such work was done with only a card and cables.
S2	I was a bit surprised to be able to make music by writing code.
S3	When I touch the water with Makey Makey, it makes a sound.
S4	I was surprised to design musical instruments from different materials and to make them sound with the help of a computer.
S5	I was surprised how useful the Makey Makey kit is and what music can teach people.
S6	To have achieved so many things on my first try.

S7	I was surprised to be able to make music with coding.
S8	I had fun for some reason.
S9	I was amazed that music can be played in code.
S10	Creating and performing musical instruments from recycled materials.
S11	Making music with fruits and even water with coding and Makey Makey kits.
S12	I didn't know that so much could be done with a few cables and aluminum foil and circuits. I didn't think that music and coding could be so intertwined.
S13	I was surprised to give sound to conductive things using Scratch and Makey Makey electronic kit.
S14	I was surprised that at the end of this activity I produced a beautiful instrument.
S15	I was very surprised to be able to play my favorite music with codes.
S16	I was very surprised to be able to make instruments with Scratch and electronic materials.
S17	I was very surprised to be able to make music with bananas.
S18	I was very surprised to be able to make music with Makey Makey electronic kits.
S19	I was very surprised to be able to produce sound from conductive things.
S20	I made and played a musical instrument for the first time.
S21	I was very surprised to be able to make music with the help of my codes and Makey Makey kits.
S22	I was very surprised to make music with the help of Makey Makey.
S23	Making music by touching water with Makey Makey surprised me a lot.
S24	The activity in which we coded with water surprised me a lot.
S25	Making music by touching the water surprised me a lot.

Table 8 presents the codes we created through student opinions given in Table 9. Under the theme of "Situations that surprised me" regarding the activity process; 6 students expressed their opinions about the combination of technology and music, 9 students about the surprising use of Makey Makey Kit, 3 students about creativity and success, 7 students about recognizing conductive materials, 1 student about coding and entertainment, and 2 students about instrument design from recycled materials. The students found the use of Makey Makey Kit to be the most interesting. They carried out many different practices with the Makey Makey Kit throughout the activity. This increased students' interest in the tools used in the activity and aroused their curiosity. The relevant tool guided students in recognizing conductive materials.

4 Discussion, conclusion and suggestions

In this study, we introduced a STEAM-based music activity for gifted students, aiming to assess their understanding of the process at the end of the activity. In this direction, the music activity carried out with the help of coding and Makey Makey electronic kits attracted the students' attention and offered them different perspectives. Özkandemir (2019) examined the effect of Scratch programming language and Makey Makey electronic card used in coding and robotics lessons in primary school 1st, 2nd and 3rd grade

music lessons on note reading and writing. 156 students participated in the study. According to the results of the 12-week training process, there was an improvement in note reading and writing activities in all classes. The students enjoyed this learning process and performed the exercises with satisfaction. Unlike the study of Özkandemir (2019), we derived the current study from a section of the doctoral thesis for exceptionally talented students. In addition, the aim of the study is to create awareness that educators can use different fields in music education effectively by offering a STEAM-based music activity to students.

In another study, undergraduate music education students at the University of Arkansas in the United States of America worked with primary school students aged 6 to 10 years to create original musical instruments and compositions with the help of Makey Makey electronic cards and coding. At the end of the research, there was an increase in the musical development of the students. For this reason, it would be beneficial for music education students to include course programs including such activities in the music departments of universities (Abrahams, 2018).

There are scientific studies that show that music improves students' computational thinking skills along with coding. Bell and Bell (2018) tried to seek ideas for meaningful ways to integrate computational thinking and music and to show how art can have a primary role in supporting computational thinking. Barate et al. (2017) designed a web tool based on integrating note teaching with algorithmic experiences using Lego blocks to increase the computational thinking skills of primary school students.

In this study, we found out that STEAM-based music activity for gifted students had positive effects on students. The students who participated in the activity enjoyed the practices, their interest in music increased, they gained awareness that music could be used effectively in different fields, they found the designs they made from recycled materials valuable and thus developed self-confidence, students who found coding boring before learned coding better with music, and learned simple electronic circuits with the help of Makey Makey kits.

The study is a part of a more comprehensive doctoral thesis. There are 4 more STEAM-based music activities in the doctoral study. At the end of the activities, students' metacognitive awareness, creativity potential and opinions about the activities were assessed. As a result, we determined that STEAM-based music activities contribute positively to students' creativity and metacognitive awareness levels. Student opinions in this study are data supporting the results of the doctoral study.

In line with the results obtained in the research, considering today's technological opportunities, utilizing them in the field of education and integrating them into music education can make positive contributions to students' learning and motivation. Especially thanks to the interaction of music with different fields, it will enrich other disciplines and provide more qualified learning environments. Similar studies to be carried out not only for gifted students but also for students of different characteristics or different age groups will help students increase their interest and motivation towards music and science.

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