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EFFECTS OF TECHNOLOGY-ENHANCED ACTIVE LEARNING ON THE MUSICAL CREATIVITY OF GIFTED STUDENTS

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Abstract. Technology-enhanced active learning increases not only gifted students' interest in learning but also facilitates the promotion of their musical creativity. This study uncovers gifted students' attitude toward technology-enhanced active learning and its effect on their musical creativity. This mixed-methods study used an experimental design followed by semi-structured interviews. We developed a control group (n = 19) and an experimental group (n = 21) of the randomly selected gifted students' age of 11–13 years old from science and art centres institution at secondary schools in Turkey. We designed an intervention to deliver music curricula through technology-enhanced active learning for the experimental group and without technology-enhanced active learning for the control group. Three experts used a rubric to measure the musical creativity of gifted students. A pre-test and post-test indicated that there was an effect of technology-enhanced active learning on the musical creativity of gifted students. Semi-structured interviews with students also suggested that gifted students have positive attitude towards technology-enhanced active learning. Students have a positive attitude towards the technology-enhanced active learning approach owing to five reasons: finding education programs beneficial, self-expression, improvement in composing skills, improvement in using technology while composing, and eagerness to continue technology-enhanced active music learning.

Keywords: creativity, curriculum, gifted students, music education, secondary school, technology-enhanced active learning.

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1. Introduction

Experts consider gifted persons as individuals who are determined to perform at a higher level than their peers in intelligence, creativity, art, or special academic fields (Kamis et al., 2019). Musical creativity is the capacity to produce innovative ideas and products (Kamis et al., 2019). These products include composition, improvising, composing soundtracks, writing songs, arranging, and interpreting classical works (Bashwiner et al., 2016). Technology-enhanced active learning (TEAL) environments and applications can be used effectively in the creative product development and music education (Gorbunova & Kameris, 2019). TEAL can help facilitate gifted children's musical creativity.

The researcher observed that gifted children learn quickly and that their creative thinking capacity is higher than other children's (Guthrie, 2019). They can put forward authentic ideas and creative solutions. Their attention and concentration spans are long when the topic appeals to them. It is an important characteristic of gifted children that they react to rhythm and melody (Councill & Fiedler, 2017). These children have a keen interest in music and composing songs, relish singing with others, and use music frequently as a tool to express

themselves. They are enthusiastic to play musical instruments, play songs by heart, are able to learn to play an instrument better and faster, and remember melodies for longer periods of time compared to their peers (Maba & Sakar, 2015).

TEAL helps learners with different technology tools, such as computers, software, hardware, and applications (Daniela et al., 2018; Hastie et al., 2011; Tlhapane & Simelane, 2010). TEAL in music education can use various software and hardware (Kahyaoğlu Erdoğmuş & Aşkım Kurt, 2022). TEAL promotes active participation in music education by preventing the formation of negative thoughts in gifted students (Gorbunova & Morozov, 2020). A music lesson enriched with TEAL makes individuals more active in some theoretical subjects, such as note training and provides more permanent acquisition by making music lessons more appealing. Learning of the note writing programs, *Encore versus Finale* in particular, has an invaluable contribution to the students' composing ability and improves their creativity (Kahyaoğlu Erdoğmuş & Aşkım Kurt, 2024; Maba, 2020). Also, Tseng and Chen (2010) suggested that music software enhanced the learning music compositions.

Various studies have documented and theorized creative thinking and the creativity features of gifted individuals through traditional learning methods (Gardner, 2011; Makel & Plucker, 2007). Technologies, which are used in developing creativity in music education, are important for individuals at all levels. However, there is a dearth of studies designed to understand TEAL gifted children, especially in music education. Therefore, this study aimed to uncover the effects of TEAL on the musical creativity of gifted children. Its major questions are:

1. Does TEAL affect the musical creativity of gifted children?
2. What are the opinions of the gifted students about TEAL-based music education programs?

We adopted a mixed-methods research approach to measure the effect of TEAL on the musical creativity of gifted children. Its quasi-experimental design in which the control group and experimental group comprised 30 gifted children. We performed a pre-test and post-test to measure the difference with TEAL and without TEAL on the musical creativity of the students. Semi-structured interviews from students helped to understand their opinions towards TEAL-oriented music education. A follow-up test after three months of intervention helped the researchers even better understand the differences.

This study has added knowledge to the field in three ways. First, it has targeted a unique sample regarding gifted children's musical creativity learning processes; second, it has observed the effect of TEAL; third, it is a methodological addition by introducing a mixed-methods approach in the multidisciplinary fields of gifted education, music education, creativity studies, and instructional technologies. The study has practical implications for teacher education institutions, the music education classroom, gifted children learning, music education pedagogy, and the parents of gifted children.

This study began with a literature review, hypothesis development, and a section on conceptual framework development. The next section discussed research methods, such as research design, sample, and data analysis followed by interpretations of the results. The results were elaborated in the discussion section. Finally, the study concluded with practical implications and future research directions.

2. Literature review

In order to advance in areas such as science, art, sports, technology, business, and politics, a society needs a qualified workforce and individuals who are capable of being leaders in these realms. By discovering gifted individuals and providing them an education in alignment with their cognitive, affective, social, and physical needs, these individuals can then offer significant contributions to our country's science, technology, art, and sports (T. C. Millî Eğitim Bakanlığı: Özel eğitim ve rehberlik hizmetleri genel müdürlüğü, 2013).

When the mental features of the gifted children are analyzed, it is seen that they learn quickly, their creative thinking capacity is high, they have a good memory, their areas of interest are broad, they can put forward authentic ideas and creative solutions, and their attention and concentration periods are long when the topic appeals to them.

Furthermore, these children's curiosity, sense of humor, abstract thinking and quick comprehension ability, retention period of the acquired information and ability to come up with creative, unique, and authentic ideas are far higher compared to their peers' ones (Levent, 2020; Sternberg et al., 2011).

Common characteristics of gifted children include reacting to rhythm and melody, a keen interest in music and composing, relishing collaborative work, using music as a tool to express themselves, enthusiasm to play musical instruments, memorization, quick learning (Kemp & Mills, 2002; Gross et al., 1999).

In several studies on gifted individuals (Csikszentmihalyi, 2004; Gardner, 2011; Kurtzberg & Amabile, 2001; Torrance, 1962), the creative thinking and creativity features of these individuals have been well documented and theorized. When the results of the studies on the link between the intelligence and creativity are examined, it is seen that there are differences between these two concepts. In some studies, creativity is seen as a feature independent from intelligence, whereas in others a medium-level link between the two has been emphasized.

In general, creativity is described as producing "something new and appropriate" (Sak, 2014, p. 14). Musical creativity is the capacity to produce new and original thoughts and products (Swanwick & Tillman, 1986). Various models such as enrichment, expediting, mentoring, and grouping are utilized to enhance the creativity and creative thinking skills of gifted individuals. Diversifying education curricula with the enrichment model helps students receive training with their peers, and diversification towards meeting the needs of gifted individuals is made possible. Enrichment types can be classified as content transfer, curriculum narrowing, independent study, site visits, and after school programs (Levent, 2020). Outcomes such as

> "composing, learning fundamental music inscriptions and components, recognizing musical instruments and differentiating their sounds, analyzing sources of sounds in the nature, vamping the music, and vocalizing the music appropriately in terms of speed and volume" (T. C. Millî Eğitim Bakanlığı: Özel eğitim ve rehberlik hizmetleri genel müdürlüğü, 2013)

are included in the music activities section in a booklet prepared by the General Directorate of Special Education and Guidance Services and consists of examples for enriched activities designed for gifted individuals.

Computer technology, which has become an indispensable part of education and training in recent years, is actively used in music education, as well. In general, computer-assisted learning (CAL) is a process whereby students interact with courses programmed by computers, and where the teacher is the guide and the computers assume the role of environment. The main objective in such education is to enrich the process with different tools such as computers (Engin et al., 2010). Presentations, videos, experiments, and music can be used to enhance the topic by means of CAL, which in turn helps students understand the topic better. CAL increases student participation, which results in more effective lesson hours. Many areas such as assessment and evaluation also benefit from CAL (Mercan et al., 2009).

CAL, which is being used in music education, as it is in other areas, reduces some of the negative thoughts of students about music education. Besides, recent advancements in music technology have provided a different dimension to music education (Demirel et al., 2001, p. 115).

Many devices, instruments, programs and software are now available owing to advancements in music technologies (Apgirlioğlu, 2003). With the help of these programs, small studios can be built at home and anything that an orchestra is capable of doing can now be done in these studios with a single computer. Programs for writing that allow users to hear what they create encourage the simultaneous use and development of several sense organs. Another advantage of these programs is that individuals can detect mistakes instantly while they listen to the music they have written (Wilkinson, 1997). A music lesson enriched with computer aid makes children more active in theoretical subjects such as note training, and will provide more permanent acquisition by making music lessons more appealing. Learning of the note writing programs, *Encore versus Finale* in particular, contributes to students' composing ability and improves their creativity (Sevinç & Koldemir, 2009).

Bakioğlu and Levent (2013), evaluating the current education system for gifted individuals in our Turkey, have concluded that formal and informal education institutions and education programs are inadequate, and, in addition, emphasized that high-level and comprehensive education programs addressing gifted individuals need to be designed. Clarke and Rowley (2008) have underlined the fact that diversified curricula promote what gifted students produce by affecting teaching and learning processes. Moreover, when the interest areas of gifted students, including their readiness and learning levels, are taken into consideration, designing and supporting composing activities play a vital role in their growing into productive individuals (Schroth et al., 2009).

The Science and Art Centers (SAC) institution in Turkey established in 1993, play an active and important role in the education of gifted individuals (Levent, 2011). However, studies directed to the education of gifted individuals and those devoted to fostering and assessing their creativity are limited (Clarke & Rowley, 2008; Bakioğlu & Levent, 2013; Sak, 2014). Today, music education is regarded as a tool rather than an aim at the SAC institution. The prime objective of SAC institution should be enhancing the artistic capabilities of the scientists instead of teaching students to play an instrument, as does a conservatory. Training programs enriched with artistic activities will support gifted individuals to maximize their thinking capabilities while working on scientific products as they grow into adults.

When Ministry of National Education (MNE, Turkey) secondary school music curricula are analyzed, it can be seen that they include TEAL based music learning and outcomes related to creativity. When the literature in the realm is analyzed, it is apparent that the curriculum does not reach its aim, and that students do not acquire the intended outcomes satisfactorily. When readiness levels and the interests of students in the study group are taken into consideration, it is observed that they participate more enthusiastically to TEAL programs. According to recent studies conducted on gifted individuals (Beckstead, 2001; Burnard, 2007; Nilsson & Folkestad, 2005; Reese & Hickey, 1999; Seddon & O'Neill, 2003; Sevinç & Koldemir, 2009; Schroth et al., 2009; Webster, 2007), there has been a dramatic increase in CAL. The hypothesis that presenting processes – particularly composing and creativity – that require high level cognitive ability with a program enriched with computer aid will help students reach their aims has paved the way for such a study to be carried out.

One of the criteria for students with high mental diagnoses in general areas, attending SAC institution is to have a score of 130 on intelligence tests. In this study, interviews with teachers working at the SAC institution have revealed that students with high diagnoses in general mental ability areas learn and improve faster compared to students with lower diagnosis in music. In this sense, this study aims to enhance the creativity of gifted students by providing them an enriched education environment while designing training programs. Promoting the creativity of gifted students with the help of enriched musical training program will help them come up with more authentic products by developing their creative thinking abilities. Diversifying training and fostering the potential of the students will enable these students, gifted in general mental ability and attending SAC institution, to merge their various knowledge and skills with informatics and music. With the help of this study, it is thought that an alternative music education program and assessment tool for gifted individuals will have a positive contribution to special education and music education.

This research aims to determine the effects of technology-enhanced musical learning program on musical creativity. Its focus is on students between the ages of 11–13 years old with diagnoses of giftedness in the area of general mental ability.

3. Method

This research used a mixed-methods approach. It used both qualitative and quantitative research approaches to achieve the research aim. We adopted a secondary school music education curriculum (T. C. Millî Eğitim Bakanlığı, 2017) from the Turkish national education programs. It suggested that teachers adapt TEAL through innovative instructional and pedagogical aspects such as the use of software, hardware, computers, simulations, and music applications. A university ethical review committee approved the proposal. This research used a semi-experimental, unequal groups pre-test and post-test design. In this design, apart from the experimental group, we developed another group to compare and control. The dependent variable of the research is the level of musical creativity of gifted students between the ages of 11–13 years old, and the independent variable is TEAL. We used TEAL to improve musical creativity in the experimental group, whereas the control group did not use the TEAL

approach. The control group continued attending music courses in SAC institution at their schools actively.

We prepared a rubric to measure the musical creativity of the students. Three experts used the rubric as a pre-test and then as a post-test to measure the creativity of the students. The intervention lasted ten weeks. Experts took a follow-up test after three months of intervention. Table 1 shows the overall research design.

Table 1. Research design (source: created by authors)

Group	Pre-test	Process	Post-test	Follow-up test
Experimental	$O_{1.1}$	X	$O_{1.2}$	$O_{1.3}$
Control	$O_{2.1}$		$O_{2.2}$	

It followed semi-structured interviews with students. These interviews helped us in uncovering students' attitudes concerning the TEAL-oriented intervention:

Evaluation rubric for creative musical product. The rubric developed by the researcher has been designed to align with musical creativity components with the purpose of evaluating the progress the students make in the pre-test, post-test, and follow-up test. A holistic rubric was designed concordant to the structure and the content of musical creativity. Holistic rubrics are graded scoring tools, mostly used in artistic studies. In such rubrics, an evaluation is done by analyzing either the completed performance or the whole product. The holistic rubric was employed here so as to gather more detailed data and to make more accurate evaluations;

Developing rubric process. To evaluate the products in a musical sense, four steps suggested by Goodrich and Tamassia (2001) have been drawn upon while developing the rubric used in the study. Moreover, while determining the criteria for evaluating the creative musical products, the outcomes of the secondary school music courses outlined by T. C. Millî Eğitim Bakanlığı (2017) have been used. The steps for developing the rubric process mentioned by Goodrich and Tamassia (2001) are as follows.

1. *Designating criteria lists*. Criteria are designated by determining the behavior the students are expected to exhibit. However, it is of critical importance that these criteria are related to the prime parts of the performance so that they can be differentiated among different samples of student works;
2. *Specifying the type of graded rubric*. Choosing "analytic" or "holistic" rubric depending on the aim of the research;
3. *Specifying performance levels*. The level/degree of the assessment is specified;
4. *Consulting an expert regarding graded rubric*. Teachers involved in realm, assessment and evaluation experts are to be consulted.

While designing the graded scoring criteria in the process of creative musical product assessment, literature on creativity, creative thinking, musical creativity, assessment of musical creativity through composing, utilizing rubric for musical creativity assessment, and the 5th–7th grade music lesson curricula of the MNE have been analyzed. Next, literature on training program outcomes designed for this research has been perused. Considering the findings gathered through analyzing the literature and outcomes of training programs, eleven criteria for graded rubric have been formed by the expert and the associate professor who are the researchers of the study.

The first criterion: "Composing a 2/4 16 measure or 4/4 8 measure song using the notes between (B)C1(Mid C) and D2". This criterion aims to determine whether students understand that they are supposed to compose a song with a specified tessitura and measure;

The second criterion: "Doing practices with two different question and answer sentences (a-b sentence)". This criterion aims to determine how effectively students can use the music to form knowledge;

The third criterion: "Using major and minor tonality engaged in terms of verbal meaning accurately". This criterion aims to determine whether students pay attention to the harmony among the lyrics and music within the rule of prosody;

The fourth criteria: "Using the terms *forte*, *piano*, *mezzo forte*, *mezzo piano*, *crescendo*, *decrescendo*, and *diminuendo*". This criterion aims to determine how effectively students use musical dynamics;

The fifth criterion: "Using the terms *andante*, *moderato*, *allegro*, *presto*, and *largo*". This criterion aims to determine how effectively students use the terms of tempo;

The sixth criterion: "Forming rhythm patterns in harmony with the prosody". This criterion aims to determine how effectively students reflect natural speech rhythms on the music while composing;

The seventh criterion: "Writing songs in harmony with the prosody". This criterion aims to determine how accurately students use closed syllable-open syllable, note duration, and stressed words in the lyrics of the songs while composing;

The eighth criterion: "Using descending-rising note scales". This criterion aims to determine whether students can write songs in the form of sequence, descending-rising, rising-descending, and symmetry;

The ninth criterion: "Converting motives (m1, m2, m3) into sentences (a, b, c) and sentences into periods (A, B, C)". This criterion aims to determine how effectively students use advanced knowledge of music forms;

The tenth criterion: "Forming melodies in different rhythmic structures". This criterion aims to determine how creative students can be within prosody rules;

The eleventh criterion: "Authenticity". This criterion aims to assess how innovative and original the composition is or whether it imitates already existing melodies.

Following the formation of the graded rubrics, assessment criteria for the rubric have been prepared for expert opinion. The rubric, its assessment key, and a sample composition to be assessed with the rubric have been sent to a professor, an expert, and a doctor in the realm of music education. Revisions have been done in alignment with their evaluations, opinions, and suggestions.

Next, a pilot scheme was conducted with 40 students to detect and eliminate the drawbacks of the rubric; the compositions written by students who exhibit normal progress have been assessed by three different raters using this rubric.

The rubric finalized in accordance with the feedback provided by the raters.

A semi-structured interview form was developed by the researchers for qualitative data. The questions were created with the support of expert opinion to reveal the TEAL oriented learning process of the students' musical creativity. Expert opinion was taken again for the final version for validity and reliability.

3.1. Research ethics

The parents of the students' age of 11–13 years signed the consent form of participation. Ethical permissions were obtained from the Dokuz Eylül University and the MNE No. 24071298. The authors assume full responsibility for the research presented.

3.2. Intervention

It was a ten-week intervention. Two hours were dedicated to intervention each week. Students were introduced to the program in the first week. They learned composition processes (prosody, rhythm, notes, rests, dynamics of music) during 2nd–3rd weeks. They learned how to use software programs to compose oral songs on computers and began creating basic level songs during 5th–7th weeks. We provided them different poems to compose during weeks 7th–10th. Finally, they began playing and singing with and without computer toward the end of the study.

The study was conducted by a single researcher to maintain group dynamics, create an environment of trust, implement experimental processes, and ensure consistency in the implementation of the plans. Experimental processes were conducted one day a week after school or on weekends, in February–April, 2018–2019 academic year. The sessions lasted 2 hours (120 minutes) on average. The study group was divided into two parts in order to maintain group dynamics and ensure the sustainability of the study. During the implementation process, a tenth week training was provided to the first group on Thursdays between 5:30 p.m.–7:30 p.m. and to the second group on Saturdays between 4 p.m.–6 p.m. The study group was divided into two parts. The physical conditions of the study environment, such as availability of computers, were another factor that made it necessary to split up the group. To increase the student motivation, warm up practices were given prior to initiating the study. These practices were designed to appeal to the participants' interests. In the first week, students were shown a presentation on music in the course of history. Practical activities regarding the formation of voice, frequency, accord, major–minor, and pentatonic sequence were included in the presentation. In the second week, *Cup Games* activities in line with activities to enhance rhythm were offered at the beginning of the lessons. In the following weeks students were asked to play games to introduce different music periods and types. A composing program designed by artificial intelligence by *Google* was introduced to the students at the beginning of the lesson and the experimental studies (compositions) devoted to the birthday of Johann Sebastian Bach. By the fifth week, the study groups were trained to use the *Finale* program. In order for the students to master the program and foster interest in the lesson, they listened and discussed the compositions that they made at home at the beginning of the lessons. The study environment was designed such that that the group members were able to work comfortably, and the stimulants used in the study were prepared beforehand, including computers, amplifiers, a projector, a xylophone, a metallophone, rhythm sticks, guitars, a *bağlama*, keyboards, plastic cups for cup games, a camera, and writing paper. The content of the sessions followed the titles below:

First week: "Basic music and notation activities";

Second week: "Rhythm studies";

Third week: "Listen to the music, find the rhythm";
Fouth week: "Finale as a means of music technology";
Fifth week: "The harmony between melody and lyrics/prosody";
Sixth week: "Proverbs with rhythms";
Seventh week: "Composing my first music";
Eighth week: "Improving my compositions";
Nineth week: "The song of the picture";
Tenth week: "Lyrics and music: me".

The process steps followed during the experimental studies are listed below:

1. Preparation of data collecting tools;
2. Preparation of lesson plans;
3. Specifying experimental and control groups;
4. Administering the pre-test to the experimental and control groups, and collecting data;
5. Scoring of the pre-test data by three experts in the realm of music (two associate professors and one doctor of philosophy);
6. Implementation of the ten-week technology-enhanced music learning program designed by the researcher (for the experimental groups);
7. Administering the post-test to the experimental and control groups;
8. Interviewing the students in the experimental group;
9. Scoring of the post-test data by three experts in the realm of music (two associate professors and one doctor of philosophy);
10. Administering a follow-up test to the experimental group;
11. Evaluation of the data collected from the follow-up test by two different experts;
12. Analyzing the data;
13. Reporting the gathered outcomes.

3.3. Study groups

The study groups comprised students between the ages of 11–13 years old who attended SAC institution in the city of İzmir, Turkey. These students were determined as gifted by the MNE. The study groups were randomly selected among students who were evaluated with giftedness and had not taken any music lessons. Students completed the consent form for participation in the study. 21 gifted students participated in the experimental group and 19 gifted students participated in the control group. Table 2 shows the distribution of students in the groups.

Table 2. Study group gender and age distribution (source: created by authors)

Group	Gender	*f*	%	Age ($\bar{x}$)
Experimental	Female	10	47.62	11.6
	Male	11	52.38	11.44
	Sum	21	100	11.52
Control	Female	8	42.10	11.5
	Male	11	57.90	11.27
	Sum	19	100	11.38

3.4. Data collecting process

We implemented two different processes for data collection: one to evaluate progress in musical creativity and the other to collect opinions about the training program. In this sense, we have followed the process below: before the experiment, we held a meeting with the experimental and control group. For the pre-test, students chose a poem with two strikes and eight verses suitable for the age groups. Students composed the poem with 2/4 or 4/4 measures. By utilizing the evaluation rubric for creative musical product, three experts evaluated the compositions. The post-test followed the same process. The follow-up test with a different poem also followed the same procedure.

3.5. Data analysis

SmartPLS 3.2.8 and *SPSS* 23.0 programs helped in data analysis. *SmartPLS* used for three reasons. First, it measured the reliability and validity of the experts' rubric evaluations. Second, it measured the effect of the categorical variables such as gender and group (*i.e.*, TEAL intervention group and control group). Third, it helped in non-parametric analysis and theory exploration.

SPSS helped in measuring the significant difference between the groups of pre-test and post-test scores gathered through the evaluation rubric for creative musical product. The suitability of the gathered data to normal distribution was determined by analyzing the Kolmogorov–Smirnov/Shapiro–Wilk Test scores and skewness and kurtosis parameters.

The analysis of variance (ANOVA) test measured whether the pre-test and post-test scores of control and experimental groups varied, for repeated measurement, 2*2 (measurement time * group). The Student's *t*-test measured whether there was a significant difference between the scores of pre-tests and post-tests of the experimental and the control groups. Finally, the Student's *t*-test was measured to see whether there was a significant difference between the scores of post-test and follow-up test of the experimental group.

3.6. Reliability and validity

We measured the reliability and validity of the output of the rubric generated by the three experts. Cronbach's alpha, rho alpha, and composite reliability helped in the consistency measurement of the rubric's outcomes. Average variance extracted (AVE) helped in measuring the divergent validity of the instrument. Cronbach's alpha and rho alpha should be above the threshold of 0.6 and composite reliability should be above the threshold of 0.7 (Asghar et al., 2021). AVE values should be above 0.5. The reliability and validity showed the Cronbach's alpha to be > 0.6, the rho alpha to be > 0.06, the composite reliability to be > 0.7, and the AVE to be > .0.5, which showed consistency, reliability, and validity of the three experts' rubrics outcomes as given in Table 3.

Table 3. Reliability and validity (source: created by authors)

Rubrics	μ	rho alpha	Composite reliability	Average variance extracted
Pre-test	0.643	0.653	0.787	0.555
Post-test	0.997	0.997	0.998	0.993
Follow-up test	0.992	0.998	0.995	0.985

We measured the moderating effects of the demographics, such as gender and TEAL on the experimental group, after measuring the reliability and validity of the rubric's outcomes. There was no effect of gender on the pre-test group with $p > 0.05$. There was no difference between groups (control and experimental) at pre-test $p > 0.05$ nor any effect of gender difference at post-test $p > .0.05$. There was a difference between groups (control and experimental) during post-test measurements (M = –0.976, $p < .001$). There was no difference owing to gender when we took follow-up measurements with $p > 0.05$. There was, however, a difference between the control group and experimental group when we took follow-up measurements (M = .801, $p < 0.001$) as given in Table 4 and in Figure 1.

Table 4. Independent *t*-test (source: created by authors)

	Mean	Standard deviation	*t*-statistics	*p*-values
Gender -> pre-test	–0.153	0.229	0.722	0.471
Group -> pre-test	–0.099	0.243	0.485	0.628
Gender -> post-test	0.059	0.036	1.527	0.127
Group -> post-test	–0.976	0.013	72.509	0.000
Gender -> follow-up test	0.064	0.079	0.864	0.388
Group -> follow-up test	0.801	0.041	19.355	0.000

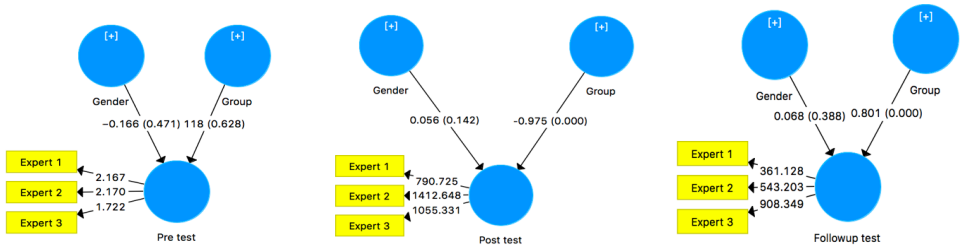

Figure 1. Pre-test, post-test, and follow-up test differences (source: created by authors)

3.7. Elaboration of results

The parametric tests of ANOVA and *t*-tests were applied on the pre-test, post-test, and follow-up test to observe the differences between the groups. It was observed that the figures of the pre-test, post-test, and follow-up test are between –2 and +2, and thus are suitable to normal distribution (pre-test skewness = 0.272, kurtosis = –1.312, post-test skewness = 0.308, kurtosis = –0.459, follow-up test skewness = 0.403, kurtosis = –0.368). In this respect, parametric approaches were used for the analysis of the data.

To determine whether the pre-test and post-test scores (evaluation rubric for the creative musical product) of the control and experimental groups varied, 2*2, ANOVA analysis was conducted for repetitive measurement (Table 5).

Table 5. Descriptive statistics of pre-test and post-test (source: created by authors)

Test		*n*	$\bar{x}$	Standard deviation
Pre-test	Experimental group	21	11.29	0.26
	Control group	19	11.35	0.28
Post-test	Experimental group	21	27.98	2.85
	Control group	19	11.26	0.33

When Table 5 was examined, it indicated that the pre-test means are close to each other; the groups were equivalent before the experiment. We measured the ANOVA results according to Mauchly's sphericity test (MST) scores (Akbulut, 2010). In this respect, since MST 2*2 ANOVA analysis is significant ($p < .05$), epsilon values must be higher than the critical level 0.90 (Abdi, 2010), thus the values in the Huynh–Feldt line given in the analysis (Table 6).

Table 6. Analysis of variance for pre-test and post-test scores (source: created by authors)

Source of variance		Sum of squares	Difference	$(M)^2$	f	p	η_p^2	Power
Within groups	Measure	1376.127	1	1376.127	589.217	0.000	.939	1.000
	Measure * Group	1405.349	1	1405.349	601.729	0.000	.941	1.000
	Error	88.750	38	2.336				
Between groups	Measure	19100.201	1	19100.201	9240.958	0.000	.996	1.000
	Measure * Group	1383.612	1	1383.612	669.412	0.000	.946	1.000
	Error	78.542	38	2.067				

According to the ANOVA results, it was observed that there was a significant difference between the pre-test and post-test scores of the participants ($F(1.38) = 589.217$; $p < 0.05$). When the effect size of this difference was analyzed ($\eta p2 = 0.939$), it showed that the effect was high (Cohen & Williamson, 1988). When the measured time and group interaction were analyzed, it reflected a significant difference between pre-test and post-test scores ($F(1.38) = 601.729$; $p < 0.05$). The effect size of this difference was also high ($\eta p2 = 0.941$). There was no significant difference between the pre-test and post-test scores of the control group. In this sense, it indicated a significant increase in the musical creativity levels of the students in the experimental group after the experiment; no significant change in the musical creativity of the students in the control group was indicated. The Figure 2, shown below, is created for measure and interaction of groups.

The diagram in Figure 2 shows that post-test scores of the students in the experimental group increased, whereas there was no change in the control group.

A month later, we conducted the post-test for the experimental group to determine whether their creativity levels changed or not. A paired Student's *t*-test assessed whether there was a significant difference between the post-test and follow-up test scores of the students in the experimental group. Table 7 shows the results in detail.

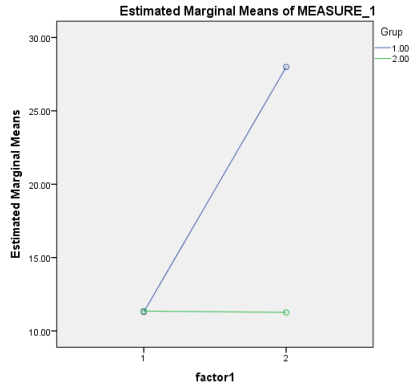

Figure 2. The graph of measures and groups (source: created by authors)

Table 7. Post-test and follow-up test scores for experimental group (source: created by authors)

		n	$\bar{x}$	Standard deviation	Difference	*t*	*p**
Experimental group	Post-test scores	21	27.98	2.85	20	1.681	0.108
	Follow-up test scores	21	27.88	2.82			

Note: *$p < 0.05$.

The data showed no significant difference between the post-test and follow-up test scores of the students in the experimental group ($t(20) = 1.681$, $p > 0.05$). In this respect, it is indicated that the musical creativity levels of the students showed no significant change.

3.8. Semi-structured interviews

An interview protocol was developed based on the statement of the problem and subsidiary statements of the problem as follows.

Does a TEAL based music learning program have an effect on the musical creativity of 11–13 years old students assessed to be gifted in the area of general mental ability?

Subsidiary statements of the problem are as follows:

1. Are there significant differences between the musical creativity pre-test and post-test scores of the students in the experimental (who received TEAL based music learning) and control group?
2. Are there significant differences between the musical creativity post-test and follow-up test scores of the students in the experimental group?
3. Are there significant differences between the musical creativity pre-test and post-test scores of the students in the experimental group in terms of gender?

The interview protocol was reviewed by five experts in the field. We conducted trial coding, frame coding, and finally, evaluated the quality of the coding. Long or short narratives in the form of sentences were taken as the units of text analysis (Schreier, 2014).

3.9. Opinions of the students in the experimental group

Using the inductive data analysis technique, two researchers analyzed the answers of the students in the experimental group. The data was converted into factors, and their percentages and frequencies were analyzed according to categories.

In the qualitative data analysis, a researcher (through concordance percentage) calculated the reliability of the researcher by conducting the analysis and data coding reliability. To achieve this, the reliability = consensus/ consensus + dissensus * 100 formula (Miles & Huberman, 1994) helped with the codes written by the two researchers conducting the study. The reliability parameter was 0.85 for the data gathered from the interviews with the students in the experimental group. Thus, reliability was met in terms of data analysis.

The answers given by the gifted students in the experimental group in the interviews were measured, and subsequently, two researchers categorized them under five factors: finding education program beneficial, self-expression, improvement in composing skills, improvement in using the technology while composing, and eagerness to continue technology-enhanced music learning.

According to the data, all the students expressed positive opinions on the factor on finding the education program beneficial. Students expressed their opinions as: "Thanks to this education program, I can now realize the critical details that are required while composing a song" (S5), "I can choose the note and the rhythm that fits the word easefully. This is a really important detail for me" (S9), "Thanks to the application on the computer, I can notate the songs and the harmonies that occur in my mind" (S11).

All the students expressed positive opinions on self-expression. Students expressed their opinions as: "Because I experimented with new things while using the program" (S3), "I corrected my mistakes. I think, thinking plausibly and accurately, I was able to ask my questions easily and reach my aims by receiving the answers I needed" (S7).

As to the factor on improvement in composing skills, once again all the students (100%) expressed positive opinions and expressed their opinions as: "I learned how to choose the right notes and rhythms while writing a melody and composing a nursery rhyme" (S13), "Because I was able to write a few melodies on my own" (S17).

When the answers concerning the factor on improvement in using the technology while composing were analyzed, it was observed that 39 of the expressions (92.5%) were positive and 3 (7.15%) were negative. Some of the positive statements were: "I had never imagined that neither at school nor at home, I could write the notes and the syllables just by using my computer and headphones and listen to it with the instrument I prefer" (S8), "Technology is a multifaceted concept, and it was a great experience to use it to make music" (S14), "I have become more enthusiastic about such areas thanks to this program. Besides, when technology is used, any activity becomes more appealing to anyone from all ages" (S18), "Since I love both music and technology a lot when they are used together, I become more excited"

(S19). One negative opinion stated, "My contribution is too low when I write a song using a computer" (S3).

Analysis of the answers for the factor on eagerness to continue TEAL based music learning revealed that 57 of the expressions (90.47%) were positive and 6 (9.53%) were negative. Some of the positive statements were: "Each week of the program equipped me with different things, and thus several more weeks would do more" (S9), "I can make music whenever I want, wherever I am as long as my computer is with me" (S10), "Having a mentor who listened to each of us" (S12), "The fact that I can write my music with *Finale*, everyone's being very broad-minded, and being able to learn something useful with fun" (S16), "Keeping up with the times by integrating art and technology bears wonderful works" (S20). In contrast, some of the negative opinions states that "No, because I think it would be exhausting" (S3), "I think we can work on our own now" (S16).

4. Discussion

Studies are available on the musical creativity of children, but there are fewer studies that address the musical creativity of gifted students, especially with the use of TEAL. Since gifted children learn quickly and become bored with classical instructional approaches for music pedagogy, this study aimed to uncover the effects of TEAL on the musical creativity of gifted students. According to our understanding, this study is among pioneer studies on the effects of technology-enhanced music education on the musical creativity of gifted children. The mixed-methods approach helped us to answer the question of whether gifted children like the TEAL-oriented program and, if so, why? We discussed the results of the study in two ways; first, we presented the knowledge addition of the study, and second, we discussed the pedagogical implications of the study.

In this study, three experts measured the pre-tests and post-test scores of the control group (without TEAL) and experimental group (with TEAL) as well as a follow-up test. We found a positive effect of TEAL on the musical creativity of the gifted children in the experimental group. Previous studies endorse our results (Addessi, 2014; Macrides & Angeli, 2020). Gifted students like innovative instructional strategies. TEAL has become part of innovative instructional approaches. Therefore, our experimental study has shown a positive influence of TEAL on gifted students' music creativity. One researcher (Burnard, 2007) states that one criterion of modernization is the necessity to promote the capacities of gifted students through efficient programs designed to enhance their knowledge and skills. Similarly, creativity, technology, and promoting pedagogic change in music education focus on the interrelationship between technology and improvement in creativity. Our study puts forward the notion that adapting music education programs at schools to advancing science and technology will ensure an improvement in students' creative thinking. A study by Seddon and O'Neill (2003), in which a program aiming to interact with computer-based composition was applied to 48 students between 13–14 years old, showed that students' musical creativity is enhanced by the opportunities offered by TEAL. Nilsson and Folkestad (2005) found in their study, the aim of which was to determine the support the technology, offers to music education, that even very young children in Western countries gain musical knowledge and skills by interacting

with technology at home, at school, and in their leisure time. They also stated that, with no interference from an adult, these children could create their music with the help of computer software.

The fact that TEAL enriched programs applied to the gifted students in the experimental group had a positive effect on their musical creativity is in parallel with results of research conducted in the realm (Burnard, 2007; Clarke & Rowley, 2008; Bakioğlu & Levent, 2013; Malkoç, 2004; Nilsson & Folkestad, 2005; Schroth et al., 2009; Reese & Hickey, 1999; Seddon & O'Neill, 2003; Webster, 2007). In their research, Clarke and Rowley (2008) maintained that diversified music learning programs enhance the productivity of gifted students with positive effects on both learning and teaching. Their research also indicated, in terms of academic programs, that various factors affected the quality of music programs and these factors bear positive results for ensuing research. In as much as gifted students have higher levels of cognitive skills compared to their peers, Bakioğlu and Levent (2013) emphasized the need for sophisticated and comprehensive programs for such students. Malkoç (2004) stated that one criterion of modernization is the necessity to promote the capacities of the gifted students through efficient and appropriate programs designed to enhance their knowledge and skills.

Second, our study uncovered gifted students' attitudes towards TEAL through semi-structured interviews. The interviews provided us with the attitudes of the students towards TEAL and why they were interested in it. The study found that TEAL-oriented education program was beneficial for the students because it helped them to enhance self-expression, composing skills, technology use while composing, and an eagerness to continue TEAL-oriented music learning.

According to our research, TEAL-based music education helps gifted students develop their musical creativity. It also provides opportunities for individuals to set up small studios in any environment and, with a single computer, create something that only an orchestra could. According to Burnard (2007) musical creativity comes from the "outside"/"out" and "inside"/"in" as a process inseparable from technology. Burnard (2007) also emphasizes the usefulness of integrating creativity and technology in aiding and extending musical learning and in specifying what it should include in the music education curriculum. Integrated music networks, new forms of musical participation, and innovative technological practices offer new learning opportunities in adaptive learning environments. Burnard (2007) further argues that, owing to the close interrelationship between technology and creativity at play through pedagogic change, a TEAL- mediated learning environment can develop musical creativity.

Researchers say that education programs do not cater to gifted students' needs sufficiently enough (Bildiren, 2017; Guignard et al., 2016). Bildiren (2017) states that the music education provided by most private and state schools through TEAL focuses on promoting the musicality and technical capabilities of gifted students; composing a song with the help of technology is also an efficient means of supporting the overall musical creativity development of students. In the regular schools, music lessons are obligatory regardless of the content and pedagogy of the program. That is why students were required to attend such courses in the schools. For this reason, music lessons should be enriched with technology and up to dated music teaching approaches.

4.1. Practical implications

This study showed that enriching and restoring music education programs, promoting proficiency levels of educators during candidacy or through in-service training, and TEAL are imperative. Wise et al. (2011) suggest that music education departments' mission is to train educators who can provide creative musical activities and organize seminars with similar contents for candidate teachers during their applied training. Putting forward the notion that educators lack knowledge and the skills to utilize the new technologies, Tomlinson (2012) underlines the need to redesign and restore music curricula and develop new resources for departments. Experts (Wise et al., 2011) also emphasize that the redesign of these programs must reflect current approaches to music education, revise the meaning of creativity, revalue the role of technology, and consider uneasiness about music lessons some students feel. Similarly, Burnard (2007) suggests that innovative and effective music education should be fostered with TEAL by "technical standards" based on "expert research" and imposed in a "top-down" manner by educational administrators and policymakers. Tomlinson (2012) maintains that gifted individuals who are not aware of their musical capabilities and composing skills can be compensated for this lack through composing applications and software under the guidance of their teachers. We offer recommendations according to the findings and outcomes of the research. Further studies on gifted individuals and their education need to be conducted. Using technology to design education programs for gifted individuals would help such programs attain their objectives. Using the enrichment method in the music education of gifted students would maintain students' positive attitudes towards music and would ensure the sustainability of the music lessons. Incorporating TEAL-oriented music education into the educational programs of the SAC institution can be used to achieve the outcome of "composing a song" included in the MNE music education program guidelines (T. C. Millî Eğitim Bakanlığı, 2017). We can conduct projects that cover different activities engaging music technologies for gifted students. Rather than instrument-based education, programs with higher student participation may be designed through which students can develop products. Music teachers can lead their students, both at SAC institution and state schools, to TEAL-oriented music learning programs and projects aimed to develop the musical product. Advancing and enhancing the knowledge and skills of candidate teachers and teachers working with gifted individuals through in-service training can pave the way for more instructional activities. Apart from intelligence tests used in placement tests, especially those administered by SAC institution, tests that can assess students' musical creativity levels should be used actively.

5. Conclusions

This study adopted a mixed-methods research approach comprised of a sequential exploratory research design. It uncovered the effects of TEAL on 11–13 years old gifted students' music creativity through experimental research and semi-structured interviews. Three music experts evaluated the students' musical creativity through rubrics. The study examined the effects of TEAL music intervention on gifted students' creativity and explored the effects of intervention on gifted students' attitudes towards TEAL-oriented music instruction. Semi-structured

interviews provided us with the insights that gifted students like the TEAL approach for the musical creativity development process. They found the TEAL approach efficient and beneficial in terms of self-expression, improvement in composing skills, improvement in technology use while composing, and eagerness to continue TEAL-oriented music learning. Because of these benefits, TEAL appears to be advantages over traditional pedagogy. Our research provided knowledge and practical additions to the previous literature. Future studies can explore the adaptation of a TEAL environment to music education curricula.

5.1. Limitations

This study was conducted on only a few students. More studies at the mass level and different educational levels should be conducted to generalize the results. Follow-up studies might measure the long-term effects of technology-oriented music pedagogy compared to traditional pedagogy on gifted students as well as others. Meanwhile, studies should also be conducted with differently abled children.

For the future studies, TEAL can be used to reveal the creative aspects of students who are especially interested in music and composition. In addition, studies should be conducted on how TEAL environments affect students who play music instruments professionally.

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