# *Music Notation Software for Smartphones: A Mobile Application Developed for Educational Purposes*

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***Abstract***

*Considering the advantages of mobile learning, in this study a free music notation software (MNS) named Musical Ear Training - Theory is developed using the Unity game engine. The MNS enables users to create, save, edit, listen, and share melodies through virtual classrooms. The study group comprised 21 students and 2 teachers from a Fine Arts High School located in the Central Anatolian Region of Turkey. As a part of the Western Music Theory and Practice course, under the guidance of teachers, the students used MNS on their personal smartphones during and outside classes for a period of 4 weeks. After the implementation, a semi-structured interview was conducted with the participating students and teachers using a form to obtain their opinions on the MNS, and a content analysis was also performed using these data. The analysis revealed that participant' opinions on the MNS were predominantly positive. The students were able to conduct several exercises in areas, such as solfeggio, dictation and composition, using MNS. Owing to the virtual classroom feature of the software, the teachers were able to share their solfeggio and dictation melodies with students via the internet, and the students were able to perform assignments outside the classroom. Implications for practice or policy: Instructors should be aware of current music education applications in mobile stores. Music education researchers should work collaboratively with technology experts to carry out joint projects on the development of music education applications. Institutional administrators should create the necessary infrastructure by encouraging the use of Musical Ear Training - Theory and other similar applications by students and teachers.*

**Keywords:** *Music notation software, Mobile application, Mobile learning, Music education, Case study.*

***E-International Journal of Educational Research***

*Vol: 14, No: 5, pp. 222-242*

*Research Article*

*Received: 2023-08-24*
*Accepted: 2023-09-26*

**Suggested Citation**

Özgül, Y. (2023). Music notation software for smartphones: A mobile application developed for educational purposes, *E-International Journal of Educational Research,* 14 (5), 222-242, DOI: https://doi.org/10.19160/e-ijer.1348703

## INTRODUCTION

Education is the process of realizing formations and changes in the individual's cognitive, psychomotor and emotional aspects that take into account himself, society and the universal. The content of this process includes knowledge of society/human and nature. One dimension of knowledge about society or people is the knowledge of art in general and music in particular (Toprakçı, 2016). Music education, which starts from pre-school period, is one of the education processes, sometimes compulsory and sometimes optional, that continues until higher education. According to Uçan (1997), music education is the process of providing the individual with certain musical behaviors through his/her own life. In order to achieve the educational purpose of music in children, teachers use various places, methods, techniques, tools and equipment (Kaptan, 2009; (Kurtuldu ve Kubaliç, 2023; Terzioğlu, 2023).

Music Notation Softwares (MNS) provide users with visual and auditory outputs of musical passages. These features have resulted in a wide range application for MNS, from the simplest (for educational purposes) to the most professional (for performance purposes). One of the leading software programs in this field is Finale music notation software (2023), which works on desktop and laptop computers. A study by Gorgoretti (2019) showed that Finale is preferred more frequently by students compared to other notation software programs such as Garageband, Cubase, and Cakewalk. Villani (2014) states that many high school educators use music notation software (MNS) in their classes. The opportunities presented by MNS render it an effective tool for music education both inside and outside the classroom.

Without a skilled musician to perform it, a notation written on paper remains a set of shapes. MNS software brings notes and other shapes to life, providing significant benefits for beginners to understand notation. As it is difficult for beginners to understand whether the melodies they perform are correct or incorrect, it is difficult for them to learn without the guidance of a teacher (Ng et al., 2015). Students can utilize music notation software to verify the accuracy of their melodies by inputting the relevant notes. Prasso (1997) examined the effect of melody notation via notation software on students' sight-singing skills and concluded that using computer-assisted notation software had a positive effect on student achievement. Similarly, Tejada (2009) found that successful students preferred MNS tools for sight-singing. MNS is also effective for instrument training. Ayderova et al. (2021) state that with MNS, students can better understand rhythmic structures and musical expressions in instrument exercises. With all these aspects, it can be said that MNS is an effective tool for students and teachers in solfege, instrument, and similar studies.



In addition to solfeggio and instrument training, composing activities are another important subcategory of music education. Students may encounter some difficulties when working on composition tasks given by educators, especially if they are working on paper. As mentioned above, understanding how a musical notation sounds is a challenging task for beginners. Music notation software (MNS) can enable students to hear how their written melodies and compositions sound, providing aural feedback and improving their critical thinking skills. Furthermore, MNS also helps students understand the notation and measure system. According to Kiraly (2003), students who write notes on a computer for a set amount of time produce more accurate and legible handwritten notes than other students who write notes in a notebook. Studies also show that using MNS to write notes increases students' motivation (Chen, 2020; Teen et al., 2014) and that students who engage in computer-assisted work tend to continue this way in their future studies (Chen, 1992).

The use of MNS and similar software in a computer environment for educational purposes also poses some problems for both students and teachers. Computer-based work confines students to rooms with computers and hinders their ability to work in a mobile fashion. With the effect of developing technology, mobile devices now offer educators a wide range of solutions, as they have gained high processing and display features. Although computers and laptops were previously dominant, MNS can now be used on smartphones due to current technology. The use of mobile technologies in education is known as mobile learning (m-learning). Although mobile learning can be performed with all mobile devices, O'Connell and Smith (2007) suggest that devices used for mobile learning should have a small screen, no external keyboard, and should be portable enough to fit into a pocket. Therefore, even though they are portable, laptops and tablets cannot be classified as mobile devices according to O'Connel and Smith (2007).

Mobile technologies have paved the way for a new type of learning, enabling students to access information and engage in activities related to their own fields without having to deal with the constraints of time and space (Martin & Ertzberger, 2013). Considering these aspects, it can be concluded in some cases, that mobile learning is more advantageous than computer-assisted learning. While mobile learning can take place anywhere, such as in classrooms, dining rooms and buses (Mehdipour & Zerehkafi, 2013), computer-assisted learning can only take place in certain indoor areas using many necessary equipment, such as an external keyboard, mouse, monitor and electrical supply. Moreover, mobile learning has certain disadvantages compared to computer-assisted learning. Mobile devices that can fit in a pocket usually come with a small screen and data entry is mostly done by tapping on the said screen. Compared to mobile devices, computers offer more convenience in terms of data entry owing to the use of keyboard and mouse. Considering that mobile devices at present are equal to or better than previous generation computers in terms of processing power (Corbeil & Valdes-Corbeil, 2007), it can be concluded that the future of mobile learning is quite promising.

In the last two decades, technology devices have become mobile, portable, and networked to the extent that they have become ubiquitous in everyday life (Baran, 2014). Mobile smartphones, with their internet connectivity feature, have brought many opportunities for music educators to use in the education process. Through education videos available on social media, students can develop their musical skills (King & Prior, 2019), and in the context of the Covid-19 pandemic, virtual classroom-oriented online video conferences can be used to conduct music lessons remotely. One another way to make music teaching enjoyable is to use games developed for mobile devices in the classroom. Games are a relatively new tool in music education (Pierce et al., 2020) and have become important and effective in helping young students gain musical knowledge and develop their musical skills (Ji, 2016; Paule-Ruiz et al., 2017). The touchscreen and other similar functions of smartphones provide an excellent environment for educational games.

As educators realize the potential mobile learning offers, their role in integrating mobile devices into the education process by considering the needs of their students from many different disciplines has become more significant (Baran, 2014). Today, mobile learning is utilized in many areas of education, including language learning, mathematics, and music education, which offers unique abilities to improve skills. Foti and Mendez (2014) suggested that exploring new strategies for integrating the use of mobile devices into higher education is necessary. Therefore, music educators have a significant responsibility in integrating mobile learning into education. To fulfil this responsibility, a free MNS was developed to be used on smartphones, and it was introduced as a sub-feature of the application named Musical Ear Training - Theory (2022-a; 2022-b) that the researcher uploaded to Google Play and AppStore. This software enables one to notate, listen to, save and share melodies with other users online through virtual classrooms over a network.



The features possessed by this software demonstrate its compatibility with the "Community of Inquiry" model. The Community of Inquiry concept is an educational model that aims to create effective learning experiences, particularly in online learning environments, by providing an environment in which students can express their thoughts, interact with each other, and manage their own learning processes (Garrison et al., 1999). This model is essentially examined under three main headings: "Social Presence," "Cognitive Presence," and "Teaching Presence" (McKerlich et al., 2011). The features of the MNS have been associated with these subheadings in the following section.

- Social Presence: It creates effective learning environments by enabling students to interact with each other (Richardson, 2001). The fact that the MNS can be run on individual smartphones allows students to interact with each other both in and outside of the classroom, enabling them to work together.

- Cognitive Presence: It expresses a series of methods that the teacher can use to shape students' thoughts and advance discussions in order to help students achieve learning goals by using critical thinking skills (Garrison et al., 2001). The MNS provides feedback to students on how composed melodies or pieces played on instruments sound. With this feedback, students have the opportunity to think critically about their compositions or musical performances.

- Teaching Presence: It includes the design, management, and guidance activities carried out by the teacher in order to create an effective learning environment (Garrison et al., 1999). The virtual classroom feature of the MNS is directed towards these activities. For example, teachers can direct

students to work on the correct content by sharing a challenging musical passage (solfeggio, instrument, etc.) with students through the virtual classroom. In this way, students can feel the guidance and presence of the teacher even in their personal work.

This study aims to reveal the opinions of teachers and students on the developed software, considering all of the above. Accordingly, the research question of the study is: "What are the opinions of teachers and students on the developed MNS?"

### *1. Music Notation Software (MNS)*

MNS was developed by the author using the Unity (2022a) game engine in a span of five years. Unity is a cross-platform game engine (Unity, 2022b) developed by Unity Technologies and is widely used in game development for IOS and Android operating systems. With Unity, applications and games for many platforms, such as Windows, Xbox and WebGL, can be developed (Unity, 2022a). The programming language of the Unity game engine, and therefore, the developed software, is C#. This game engine was used in the development of MNS as it is superior to others in developing mobile applications. Furthermore, Unity was preferred as it uses C# as its programming language. C# is intended to be a simple, modern, all-purpose and object-oriented programming language ("C Sharp", 2022).

### *2. Current Usage of MNS*

MNS has been published by the author as a free sub-feature of the Musical Ear Training - Theory application on Google Play Store and AppStore (Musical Ear Training - Theory, 2022a; Musical Ear Training - Theory, 2022b). Moreover, all features of the application can be used for free (Although some applications and games can be downloaded for free, certain features in these applications and games may require users to pay money). In this published application, apart from MNS, there are various study modules that can utilize some features of MNS, such as pitch identification and chord construction. Although necessary actions are being undertaken by the researcher to add new study modules to the application, the study modules except MNS are outside the scope of this study.

### *3. Limitations of MNS*

In this section, the limitations of MNS are explained. The fact that the software and source codes belong to the researcher implies that these limitations can be eliminated by the researcher in time, as needed.



1. Note lengths: The shortest identifiable notation on MNS is a 16th note, whereas the largest is a whole note. A note longer than a whole note can be formed using ties (Figure 1).

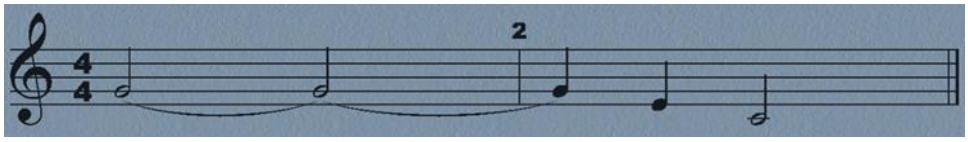


**Figure 1.** *Example of five-beat note on MNS*

Figure 1 shows that a five-beat G is produced by combining 2 half notes and 1 quarter note with a tie. Notes of the desired length can be created using ties.

2. Accidentals: Accidentals on MNS are limited to flat, double flat, natural, sharp and double sharp.

3. Clefs: On MNS, the clefs are limited to the G and F.

4. Key signatures: MNS covers all Western music key signatures.

5. Pitch range: Pitch ranges on MNS vary by keys (Figure 2).

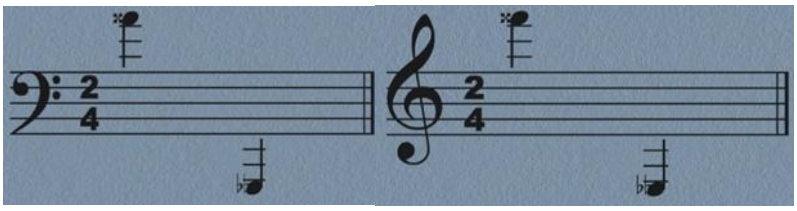


**Figure 2.** *Pitch ranges on MNS*

Figure 2 shows that the pitch range of a melody to be composed with the bass clef is G1(bb)-A4(x), and the pitch range of a melody to be composed with the treble clef is F6(bb)-E3(x).

6. Time signatures: The time signatures that can be identified on MNS are limited to 2/4, 3/4, 4/4, 3/8, 6/8 and 9/8.

7. Tuplets: On MNS, a tuplet can only be achieved by dividing the quarter note into three. On the software, a tuplet can be identified in 2/4, 3/4 and 4/4 melodies and at the beginning of the beats.

8. Language: The mobile application MNS uses supports Turkish and English. With the support of foreign academicians who are experts in the field of music, new language options can be easily added.

9. Polyphony: MNS is designed to compose monophonic melodies. Polyphonic melodies are not yet supported.

10. Measure count: MNS supports up to 16 measure melodies.

11. Platform: MNS is designed for smartphones with IOS and Android operating systems. With minor changes to the software, MNS can also be used on different platforms, such as Windows and Linux.

### 4. *MNS on Smartboards*

As a part of the FATIH project conducted by the Ministry of National Education (MoNE) in 2010 (Çoruk & Tutkun, 2018), interactive LCD panels (smartboards) with internet connection were installed in 570,000 classrooms in different schools around Turkey to offer students a technology-supported learning experience (Koçak & Gülcü, 2013). FATIH (Movement of Enhancing Opportunities and Improving Technology) is one of its most extensive projects (Çoruk & Tutkun, 2018). Although teachers' opinions on smartboards are positive (Koçak & Gülcü, 2013; Çoruk & Tutkun, 2018), they also emphasize software deficiencies (Kırbaş, 2018; Çoruk & Tutkun, 2018; Koçak & Gülcü, 2013). These deficiencies manifest themselves in the field of music education no less than in other fields.

Smartboards installed in classrooms as a part of the FATIH project are basically computers with an LCD touchscreen. Therefore, the Windows operating system is installed on them (Ekici & Yılmaz, 2013; Bayrak et al., 2014). Although the software developed by the researcher is designed for smartphones, the Unity (2022a) game engine, with which the software is developed, allows the software to function on numerous platforms. Accordingly, the researcher produced a version of MNS that can function on smartboards that have the Windows operating system installed on them. The smartboard version of the software has mouse and keyboard support. Moreover, the touchpad features of smartboards are similar to the touchpad features of smartphones, which have provided great convenience for the researcher. The researcher manually installed MNS on the smart boards. MNS has not yet been published on the Microsoft Store (2022). below.



## METHOD

### 1. *Research Model*

In this study, the case study model, which is one of the qualitative research methods, was used. The case study model is an important method used in evaluation research (Aytaçlı, 2012). Creswell (2007) defines the case study model as a qualitative approach that involves an in-depth examination of one or more cases, utilizing multiple data collection tools to uncover themes and sub-themes relevant to these cases, while Subaşı and Okumuş (2017) characterize it as a systematic method for collecting data and investigating real-world phenomena. In this study, the case is the developed software (MNS), while the themes are the students' and teachers' opinions about this software.

There are several reasons why the case study model was used in this research. Firstly, it is not possible to evaluate MNS as a tool for developing musical skills alone. To determine how educators and students use MNS in their musical studies, the case study model was employed with open-ended questions. In case studies, the researcher has little control over the events (Yin, 1984). In this study, the researcher provided the developed MNS to students and teachers for their use, without intervening in the implementation process. The main functions of MNS in real working environments were planned to be revealed based on the obtained sub-themes.

### 2. *Study Group*

The study group was determined using the homogeneous sampling method, which is one of the purposive sampling methods. In this method, a homogeneous sub-group related to the research problem is selected from the population (Baltacı, 2018). In line with the research question, the study

group comprises 2 music teachers working in a Fine Arts High School located in the Central Anatolian Region of Turkey and 9th and 10th-grade students from the same school who enrolled for the Western music theory and practice course taught by participant teachers in the spring term of the 2021–2022 academic year. The content of the 9th- and 10th-grade Western music theory and practice course includes units, such as basic music terms, note-rest durations, musical reading and musical notation (MEB, 2018). The total number of 9th- and 10th-grade students who enrolled for the said course was 35. As the research data were collected in the last week of the semester, some of the students were absent due to final exams; therefore, data were collected from a total of 21 students. Before the implementation, necessary permissions were obtained from the Ministry of National Education, and following that, teachers and students were asked to complete the participant consent form. Additionally, written consent was obtained from the participating students' parents with the parental consent form.

### *3. Data Collection Tools*

Two semi-structured interview forms were developed to collect the opinions of students and teachers regarding the MNS software (App. 1). These forms aimed to obtain the following data:

1. Areas of utilization of MNS inside and outside the classroom.
2. Potential benefits of MNS for students to comprehend the topic covered.
3. The practicality of MNS.
4. Problems encountered while using MNS.
5. Parent opinions on MNS.
6. Opportunities the virtual classroom feature offers.

### *4. Pre-Implementation, Implementation Phases and Data Collection*

Before the implementation, the researcher performed a preliminary interview with two teachers in the study group. As a result of the interview, it was observed that the teachers were willing to use MNS on smartboards and they wanted to share melodies with students online through virtual classes. Therefore, the researcher produced a version of MNS that is compatible with smartboards and manually installed the software on smartboards in the Fine Arts High School where the implementation was conducted. The researcher added the virtual classroom feature in the customized software in accordance with the teachers' demand, allowing users to share melodies through virtual classrooms. Following installations on personal smartphones and smartboards used by teachers, the researcher organized a meeting with the teachers and provided information regarding the general use of MNS and its virtual classroom feature. Before the implementation, the students in the study group downloaded MNS on their personal smartphones from Google Play Store and AppStore under the supervision of the researcher, and following the installation, membership steps were undertaken to enable access to virtual classrooms managed by teachers.



During the implementation process, no direction was given by the researcher to the teachers who conducted the course. The implementation was performed for a total of four weeks as a part of the Western music theory and practice course (MEB, 2018) that was taught for two periods a week. Throughout the implementation, the teachers who instructed the course ensured that students used MNS actively during classes and outside the classroom and acquired various skills related to learning outcomes specified in the curriculum (Figures 3 and 4).

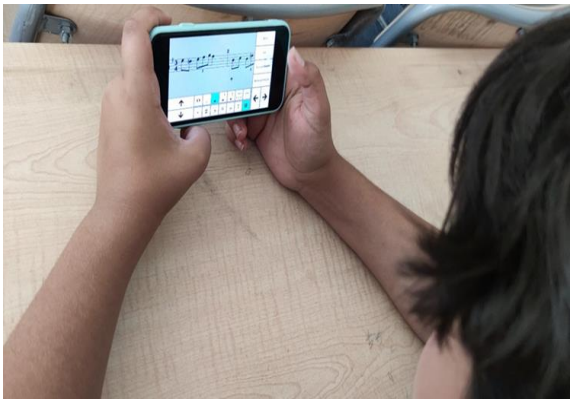

**Figure 3.** *A student using MNS on their smartphone*

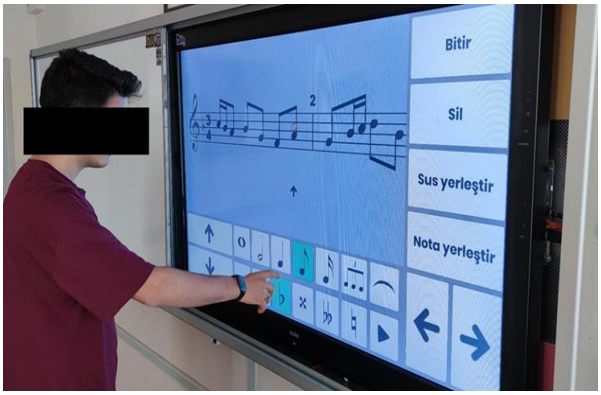


**Figure 4.** *A student using MNS on the smartboard*

After the implementation, semi-structured interviews were conducted with the teachers and students using the form developed by the researcher to collect opinions of the study group about MNS.

### 5. Data Analysis

In qualitative research, data obtained through observation, interview or documents are examined and analysed through descriptive or content analysis (Öğülmüş, 1991). The content analysis aims to identify the basic concepts that can explain the qualitative data obtained by collecting opinions and to reveal the relationships between these concepts (Aykaç, 2011). In line with this purpose, content analysis is performed to code the data, the themes and codes are determined and organized, and finally, data are presented and interpreted in the findings section (Yıldırım & Şimşek, 2011). Thus, the researcher draws inferences to interpret various meanings and messages from the texts using data obtained from participants (Büyüköztürk et al., 2011). In this study, content analysis was performed on the data obtained from semi-structured interviews conducted by the researcher following four weeks of practice using the developed forms. In accordance with the responses given to each question on the interview forms, codes were established, and for each question, a sample participant opinion was presented in the study's findings section. Sample participant opinions were presented by anonymizing the names of the participants and considering ethical principles; no personal data were asked from participants. The researcher occasionally corrected spelling issues in the example participant opinions reported in the findings section while maintaining the semantic integrity of the phrases.

### 6. Validity and Reliability

In quantitative research, findings can be analysed by minimizing the researcher's influence through various numerical analyses, whereas in qualitative studies, it is suggested that the concepts of confirmability be preferred over the concept of objectivity, as the influence of the researcher cannot be eliminated (Yıldırım & Şimşek, 2011). User confirmation, variation, long-term observation, expert review and researcher's biases are assumed to be some of the main factors that improve the credibility of qualitative research (Merriam, 1998). For there to be external validity, the findings need to be explained comprehensively in addition to being transferable (Schofield, 1993). The extent to which the evaluations made by the researcher and other field experts coincide (reliability) is of significant importance to maintain consistency in analysis (Gibson & Brown, 2009).

#### 6.1. Validity



Participant confirmation: For the purpose of objective evaluation, the researcher, a teacher and a student were allowed to comment on the findings, and the three exchanged ideas about the obtained results. Variation: For obtaining in-depth information, the researcher conducted semi-structured interviews with students and teachers using the developed forms. The inclusion of teachers in the data collection process helped reveal the impact of the developed software on the classes. Long-term observation: Prior to data collection, the researcher conducted preliminary interviews with the teachers in the study group and obtained information about the course. As a result of these interviews and consistent with the demands of the participating teachers, a version of MNS that is compatible with smartboards was developed and virtual classroom features were added to the software. Expert review: During the development of semi-structured interview forms, opinions of expert academicians in the field of music education and teachers in the study group were obtained, and data collection tools were arranged accordingly. Researcher's bias: During data analysis, the researcher conveyed the findings as they were, without prejudice. Detailed description: Extensive information regarding the determination of the study group, data collection tools and utilization of MNS inside and outside the classroom were presented in detail in the study.

#### 6.2. Reliability

Collecting the opinions of different experts: Qualitative data obtained from semi-structured interviews were interpreted by the researcher after transcription. Following that, five interview forms randomly selected by the researcher were examined by another field expert, and it was investigated whether the comments obtained from the field expert were compatible with those of the researcher. A compatibility rate of 80% or higher implied that the coding conducted by the researcher was reliable (Huck, 1996). The compatibility rate obtained in this study was 86%. Therefore, it can be concluded that the researcher's interpretation of participants' opinions is reliable. Presenting evidence: One of the most significant outcomes of this research is that the application developed by the researcher can be used on smartphones. This application has been published by the researcher on Google Play Store and AppStore and made available worldwide. Moreover, visual instructions for the use of this application on students' individual smartphones and smartboards during class are presented in the study. below.

## FINDINGS

### 1. Findings Obtained from Semi-Structured Interviews with Students

**Table 1.** *Opinions of students on the benefits of notation application*

| Code | Student opinion | f |
|---|---|---|
| It was helpful | "As it covers many topics of Western music course that I am taking, it is a useful software." (S1) | 21 |
| Detecting pitches | "With this software, I can better detect the pitches I hear." (S2) | 8 |
| Notation skills | "Thanks to this software, my musical notation skills improved." (S6) | 7 |
| Note positions | "This software helped me learn the positions of notes." (S11) | 6 |
| Dictation skills | "I started to dictate better." (S9) | 5 |
| Solfeggio skills | "I can read Solfeggio passages more easily now." (S18) | 5 |
| Measure skills | "I can now place the notes in the measure correctly." (S16) | 3 |
| Ability to detect rhythm | "The software helped me learn about beats and rhythms." (S1) | 2 |
| Instrument playing skills | "Improving our hearing skills, this software will positively affect our instrument playing skills in the future." (S4) | 1 |
| Melody writing skills | "The software enabled me to compose a regular melody on my own." (S16) | 1 |
| Signs and symbols | "Before using this software, I could never understand the works I observed. Afterward, I learned about the signs and symbols in the notation. Since then, everything is better." (S19) | 1 |
| Realized my mistakes | "Thanks to this software, I had the chance to see my mistakes and act on them." (S20) | 1 |

Table 1 shows that all participant students regard the notation software to be beneficial for themselves. Students also stated that owing to the software, their pitch perception (n = 8), notation (n = 7), note positioning (n = 6), dictation (n = 5), solfeggio reading (n = 5), measure (n = 3), rhythm perceiving (n = 2), instrument playing (n = 1), melody writing (n = 1) and signs-symbols knowledge (n = 1) improved. One student stated that after using the software, they could easily identify their mistakes.

**Table 2.** *Students' opinions on the purposes of using the notation application*

| Code | Student opinion | f |
|---|---|---|
| Developing musical skills | "I used the application to improve my musical skills." (S2) | 13 |
| Writing a melody the notes of which are known | "I tried to write J. S. Bach's Menuet No.3." (S8) | 8 |
| Dictation practice | "I used the application to improve my dictation skills." (S11) | 7 |
| Solfeggio practice | "I prepared for solfeggio exams by practising with the application." (S6) | 5 |
| Doing homework | "I did the homework given by the instructor using the application." (S17) | 5 |
| Identify intervals | "I used the application to identify intervals." (S7) | 3 |
| Composition | "I composed works inspired by my guitar compositions." (S15) | 3 |
| Notating folk songs | "I notated some folk songs using my own patterns." (S12) | 1 |
| Dictation of a known melody | "I used the application to attempt and dictate the music I listened to. Meanwhile, I listened and checked the notes I wrote." (S10) | 1 |
| Listening to the melody | "I used the application to focus on the melody." (S21) | 1 |
| Entertainment | "I used this application for entertainment." (S3) | 1 |



Table 2 reveals that many students (n = 13) use the application to improve their musical skills. The students also stated that they used the application to notate a known melody (n = 8), practise dictation (n = 7), practise solfeggio (n = 5), do homework (n = 5), identify intervals (n = 3), compose (n = 3), notate folk songs (n = 1) and dictate a known melody (n = 1).

**Table 3.** *Opinions of students about their willingness to continue using the application during classes in the future*

| Code | Student opinion | f |
|---|---|---|
| Yes I would | "Yes, I would. It is a very nice and informative application." (S8) | 21 |
| It is a useful application | "Yes, I would. This application is very useful in the classroom environment." (S1) | 5 |
| Develops the musical ear | "I would like to. Because this application improves my musical ear." (S11) | 2 |
| Encourage exercise class participation | "Yes, I would. Exercise class participation increases thanks to the application." (S2) | 1 |
| Accessibility by personal smartphones | "Yes. Because our smartphones are always with us, the application is easy to access." (S16) | 1 |
| More fun to notate in a notebook | "I would like to. Because it is much easier and more fun than notating in a notebook." (S17) | 1 |
| More efficient to use at home | "Actually, it would be more efficient to use this application at home. The application can be used during the class as well." (S4) | 1 |
| The application needs to be improved | "Of course I would. If the application is improved a little more, it will be more fun and we will be more eager to use it." (S20) | 1 |

Table 3 shows that all participating students would like to continue using the application in the future. It was observed that the application is useful (n = 5), develops the musical ear (n = 2), encourages

class exercise participation (n = 1), is easily accessible (n = 1) and offers more fun than writing notes in the notebook (n = 1), which contributed to students' preference to use the application in the future. Moreover, a student stated that the application would be more useful to use at home, whereas another stated that it would be more fun if the application was improved.

**Table 4.** *Student opinions on the reactions of their parents while using the application at home*

| Code | Student opinion | f |
|---|---|---|
| Did not use the application while with parents | "Since I did not use the application while I was with my parents, they did not have any reaction." (S13) | 7 |
| Liked it | "Their reaction was good. I showed the app to them, too. They found it a bit confusing, but they liked it." (S20) | 3 |
| No unusual reaction | "Since I have practised this before, they did not have an unusual reaction." (S5) | 2 |
| Even if they saw it, they would not react. | "I don't think my parents would react to it because the application contributes to my school life and is a part of the course. They do not interfere with what I do on the phone." (S2) | 2 |
| Pleased | "They were happy to see that I was studying." (S18) | 2 |
| Improved attitude towards music | "Their reaction was positive. My parents' attitude towards music has improved." (S14) | 1 |
| Found it useful | "My parents always ask me to practice on the notation application when I am free. In other words, they found it very useful." (S19) | 1 |
| Wrote a song with the parents | "We wrote a Fenerbahçe anthem with my parents. Then, we tried to notate a song that we deeply enjoy and they liked it very much." (S4) | 1 |
| No student comments | - | 2 |

Table 4 reveals that some of the participant students (n = 9) do not use the application while with their parents, and the parents of other students who use it generally have positive opinions about it. Finally, two students did not answer this question.

**Table 5.** *Student opinions on the problems experienced while using the application*

| Code | Student opinion | f |
|---|---|---|
| No problems | "Frankly, I did not encounter any problems because the application works very well." (S6) | 16 |
| Complicated | "When I first ran the app, it looked very confusing. I learned how to use it later on. It would be very nice if the confusing parts of the application were eliminated." (S20) | 2 |
| Difficulty in melody saving | "I had difficulty saving the melodies I composed." (S14) | 1 |
| Page layout | "Page layout and staff in the application were not user-friendly." (S10) | 1 |
| Application not running | "There were times when I could not open the application." (S18) | 1 |



Table 5 shows that most of the participant students did not encounter any problems while using the application, whereas two students found the application confusing and one student faced difficulty saving a melody. Moreover, the data show that one student had problems with the page layout and another student had problems with running the application.

**Table 6.** *Students' suggestions on the notation application*

| Code | Student opinion | f |
|---|---|---|
| No suggestions | "The application offers all essentials and is very useful for music students." (S1) | 14 |
| C clef should be added | "I would like to use the C clef while notating." (S7) | 2 |
| Turkish music | "It will be more useful if the application offers Turkish music notation capability." (S12) | 2 |
| Export | "It would be nice if the melodies could be easily exported." (S10) | 1 |
| Horizontal screen | "A new page layout where staffs are placed in a row in a way to enable changes to be made easier." (S10) | 1 |
| Graphics | "The graphics of the application can be improved." (S12) | 1 |
| Pitch identification | "If a pitch identification feature is added to the application, we can understand whether we read the solfeggio pieces correctly." (S16) | 1 |
| Topic notes | "Topic notes can be added to the application. Thus, we can learn more easily and reinforce the subjects." (S18) | 1 |
| Large-scale events | "More large-scale events can be added to the application." (S4) | 1 |

Table 6 shows that of the total participants, 14 students did not offer any suggestion regarding the application, two suggested adding the C clef to the application, two wanted Turkish music elements to be added to the application, and one suggested exporting melodies. The students also recommended that the notes should be displayed in a different page layout, graphics should be improved, a pitch identification system should be utilized for controlled solfeggio exercises, topic notes should be added, and large-scale activities should be introduced.

### 2. Findings Obtained from Semi-Structured Interviews wtih the Teachers

**Table 7.** *Teachers' views on the benefits of MNS to the course and students*

| Code | Teacher opinion | f |
|---|---|---|
| Turkish | "The most important aspect of the application is that it is in Turkish. I see it as a pro for students to have an application in their own language so that they can access the information they want." (T1) | 2 |
| Measure skills | "It allowed students to see whether the note patterns they use while separating the measures into equal beats during notation are excessive or missing." (T2) | 1 |
| Solfeggio, dictation | "It made it easier for students to do exercises on aspects, such as hearing, solfeggio and dictation, both at school and at home. The students now have the opportunity to listen and repeat the passages they had difficulty in reading during the choir classes by notating them on the application." (T2) | 1 |
| Piano | "The application offers great convenience for students who do not have a piano at home." (T2) | 1 |
| Rhythmic and aural | "Owing to the application, students can see the duration and the rhythm properties of the notes, and they can also benefit from the app in the aural sense by performing pitch exercises." (T1) | 1 |
| Can be used anywhere | "Students are able to practice in any environment, even by using their smartphones, without needing complicated material." (T2) | 1 |

Table 7 shows that teachers find the use of MNS beneficial as it supports the Turkish language, helps students understand the measure system better, and reinforces solfeggio and dictation exercises.

**Table 8.** *Teachers' opinions on the use purposes of notation application in the classroom*

| Code | Teacher opinion | f |
|---|---|---|
| Aural and theoretical exercises | "The application was used in teaching pitch identification, melody dictation and rhythmic patterns." (T1) | 2 |
| Saving time | "Sometimes, when we wrote the notes on a whiteboard by drawing a staff, it lost at least a 10-minute part of the class. Using this software on smartboards not only enriched the course content but also reduced the amount of time spent unnecessarily and facilitated more direct instruction." (T2) | 1 |
| Mobility | "The fact that the software can be used on smartphones has made it easier for students to practice anywhere and has provided us the opportunity to follow up on the assignments." (T2) | 1 |



Table 8 shows that teachers use the application for aural and theoretical exercises. The table further shows that notation on the smartboard instead of the whiteboard saves time and enables the course to be taught more effectively.

**Table 9.** *Teachers' perspectives on the motivations for encouraging pupils to utilize the notation application outside of the classroom*

| Code | Teacher opinion | f |
|---|---|---|
| Recognizing pitches | "The application helps students recognize pitches, be constantly intertwined with sounds and build a sound schema in their memory." (T1) | 1 |
| Skills | "In music lessons, students were allowed to use the application to help them develop their basic knowledge and skills." (T1) | 1 |
| Composition | "When we ask students to compose short melodies containing the topics covered, they can easily do this on their phones and send us their assignment." (T2) | 1 |
| Solfeggio | "Even if they do not have a piano or any other instrument, the students are able to read their solfeggio exercises by utilizing the necessary pitches on the application." (T2) | 1 |
| Dictation | "While preparing for the musical hearing, notation and reading exams, students do exercises on topics, such as rhythm dictation, using the melodies available on the application." (T2) | 1 |

Table 9 shows that teachers encourage students to use MNS outside the classroom environment as well as it helps students acquire basic skills, such as solfeggio and dictation, and compose melodies.

**Table 10.** *Teachers' opinions on the contributions of the virtual classroom feature to their class*

| Code | Teacher opinion | f |
|---|---|---|
| Commitment to the course | "Owing to the virtual classroom feature of the application, students' commitment to the course is ensured outside the classroom environment as well. Thus, while information is readily available to students, it is also made sure that the students retain the information they learn." (T1) | 1 |
| Assignment | "We had the opportunity to assign homework to students in the virtual classroom environment and to follow up on their homework." (T2) | 1 |

Table 10 shows that owing to the virtual classroom feature of the application, teachers can assign students homework, thereby contributing to students' commitment to the course outside the classroom environment as well.

**Table 11.** *Teachers' views on changes in the students' attitudes towards the course after using the notation application*

| Code | Teacher opinion | f |
|---|---|---|
| Enjoyable | "The music notation application is a fun way of learning for students and a fun way of instructing for teachers." (T1) | 1 |
| Playing with notes | "Students tend to produce their own melody or melodies by playing with notes using the application." (T1) | 1 |
| Overcoming fear | "Students' attitudes towards courses to which they fearfully approached have changed; in fact, they have realized that they can do certain things more easily when they have the opportunity to practise on them whenever they want." (T2) | 1 |
| The importance of repetition | "They understood that repetition is of significant importance in understanding the course contents and comprehending the subject. The fact that this is a user-friendly application that can be easily accessed with all smartphones made it even more appealing." (T2) | 1 |

Table 11 shows that an entertaining environment is created in the classroom owing to MNS. Presently, students tend to produce their own melodies by playing with pitches, their attitude towards the subjects they had initially avoided has changed and they have realized the value of repetition.

**Table 12.** *Teachers' opinions on the problems experienced while using the application*

| Code | Teacher opinion | f |
|---|---|---|
| No problems | "I encountered no specific problem, neither while installing nor while using the application." (T1) | 2 |

Table 12 indicates that teachers did not encounter any problems while using MNS.

***Table 13.*** *Teachers' recommendations for notation application*

| Code | Teacher opinion | f |
|---|---|---|
| Polyphony | "The application can be improved to enable composing and listening to 2-part dictations and choral parts." (T1) | 1 |
| Feedback | "A feedback mechanism can be integrated into the virtual classroom feature to determine whether the assigned homework has been completed. Thus, the teacher will be able to observe the overall condition of the class." (T2) | 1 |



Table 13 shows that one participant teacher suggested improvements in the application by introducing a polyphonic melody feature, whereas another teacher recommended integrating a feedback mechanism into the virtual classroom feature.

## DISCUSSION, CONCLUSION AND RECOMMENDATIONS

Musical notation, with its unique shapes and symbols, is one of the most prominent elements that differentiate music education applications from other educational applications. It is impossible to instruct numerous aspects of music education, such as sight-singing and dictation, with applications that do not have an extensive interactive notation feature. When the notation feature is interactive, it also allows users to produce music (Ji, 2016). Considering the importance of interactive music notation for music education, this study aims to develop a musical notation application that can be used on smartphones. The above-mentioned advantages of mobile learning are among the prominent factors that encouraged the researcher to conduct this study. The notation software, developed with Unity game engine, is available on Google Play Store and AppStore as Musical Ear Training - Theory. This application, in addition to its notation feature, includes many sub-study modules, such as pitch identification and melodic dictation, and the researcher is actively working to add new educational modules to this application.

The notation application basically performs the functions of creating, saving, editing and listening to melodies. Users can also share the melodies they have created with each other through virtual classrooms. The study group comprises 21 students from a Fine Arts High School in a province located in the Central Anatolian Region of Turkey and 2 teachers from the same school. It has been observed in pre-interviews held prior to the implementation that the teachers in the study group wanted to use this application on smartboards as well. Accordingly, the researcher developed a version of the application that can be used on smartboards and installed the software on these boards manually. Before the implementation, the application was also installed on individual smartphones of participant students

and teachers and they were briefly informed about the application. The researcher did not guide the participant teachers on the application's intended learning outcomes. The implementation lasted for a total of four weeks and following that a semi-structured interview was conducted with the members of the study group using the form developed by the researcher to collect their opinions regarding the software.

As technology becomes more prominent in education, the findings obtained in similar studies have shown that technology positively contributes to learning and teaching (Güçlü et al., 2021). Data obtained from this study also show that teachers and students exhibit positive attitudes towards the use of the developed application in class and extra-curricular activities. It is thought that doing activities that are different from traditional ones contributes to this result. Goncharova and Gorbunova (2020) emphasized that devices, such as tablets, are always attractive to children and that using them to create music theory lessons can help engage pupils. In this study, one of the participant teachers stated that the application fostered a fun learning environment for students, and students in the study group stated that they desired to continue performing mobile learning-supported in-class activities in the near future. This study's finding that participant students are eager to continue performing such activities in the future is consistent with the findings of Chen (1992).

Educators should understand the benefits and challenges of conducting mobile learning activities in accordance with the current curriculum to effectively use mobile technologies in educational environments (Lai et al., 2016). The study group comprising students were enrolled in the Western music theory and practise course, and in accordance with the course's learning objectives, the teachers of this course guided the students inside and outside of the classroom on how to utilize the notation application. Data obtained show that the teachers usually provided guidance to students in performing solfeggio and dictation exercises on the application. Owing to the online melody sharing feature of the application, teachers were able to create solfeggio and dictation melodies on their smartphones and were able to share these melodies with students through virtual classrooms. Students stated that they used this feature in preparing for solfeggio and dictation exams. Students usually performed solfeggio practices on the application by listening to the solfeggio while observing the notes on the notation screen and repeating them in real-time. It is stated that students listening to melodies on the application will possess the ability to adjust the tempo, use a real-time green line, observe the unit beats and identify pitches, thereby contributing to their solfeggio skills. In another study conducted on the subject (Prasso, 1997), it was observed that notating and listening to choral melodies in a computer environment contributed significantly to the success of students in sight-singing.



A participant student recommended that pitch identification feature can be added to the application to provide feedback on whether the solfeggio parts are read accurately. Although the application developed by the researcher features numerous study modules (dictation, pitch definition, etc.) apart from the notation feature, the study module mentioned by the student has not yet been developed and work is in progress on the development of this module. Dictation practices, which have been developed like solfeggio practices, can also be conducted on the notation screen. If the melodies are unknown to students, they cannot practice dictation without the help of a second person or device (Özgül, 2016). By downloading the melodies uploaded by their teachers using virtual classrooms, students can perform dictation exercises without the help of a second person. Considering that musical development is closely related to the environment at home (Chung & Wu, 2017), one of the important elements that distinguish this study is that students can be assigned homework solfeggio and dictation melodies through virtual classrooms.

Homework is a crucial tool for tracking learning inside and outside of the classroom (Yel & Ural, 2020). Moreover, Uzun and Keleş (2012) stated that students expect the teacher to check whether the assigned homework is done. Alternatively, the application developed in this study allows teachers to send melodies through virtual classrooms and does not provide any feedback about students' homework performance. A teacher in the study group stated that they wanted to observe the homework performances of students so that the level of comprehension of subjects can be better understood. For example, observing how many students do a dictation homework assigned via the virtual classroom, how much time they spend on dictation, their homework performance and the class average will improve the quality of the delivered education. A teacher feedback system is planned to be integrated into the virtual classroom feature. This new feature is expected to enable teachers to monitor student

performance, encourage more practice outside the classroom (Bülbül et al., 2006), and boost motivation. However, it should be noted that the remote measurement is convenient for students to cheat (Corbeil & Valdes-Corbeil, 2007).

The study findings show that only one of the participant students associated notation with instrument training owing to the use of musical notation in the Western music and theory course. When the target achievements of this course are examined (MEB, 2018), it is observed that there is no content on instrument teaching. Similar to solfeggio exercises, students can perform musical notation during instrument exercises. Notation exercises can provide students with an insight into how a melody should sound rhythmically and fretfully in individual instrument practices (Ng et al., 2015). As it is a mobile application, it allows students to practice instruments without the requirement of insulated study rooms at schools or desktop computers and paid software.

The obtained data show that students use the application for recreational activities besides completing their assigned homework. Among these activities are composing, notating melodies (the notes of which are known) or attempting to score a piece of music by dictating a known melody. For instance, a student stated that they attempted to notate a Fenerbahçe anthem with their parents and that they had immense fun while doing it. Furthermore, the findings show that students' parents have a positive attitude towards the notation application. A participant student stated that their parents wanted them to use the application constantly in their spare time. Studies in this area show that parents are cautious about their child's use of smartphones (Radesky et al., 2016; Al-Jarrah et al., 2019); however, when these technologies are used for educational purposes, parents exhibit a positive attitude (Özdamlı & Yıldız, 2014).

In this study, a participant teacher stated that as the developed application has Turkish language support, it allows students to access the information they want in their own language. When the comments made on the most-downloaded music education applications (Perfect Ear, 2022; My Ear Training, 2022) on the Google Play Store are examined, most Turkish users requested the developers to add Turkish language support to these applications (to see the Turkish comments, the system language of the computer or phone used must be Turkish). The obtained data also show that two participant students recommended that Turkish music notation system elements should be added to the application. Although there are numerous Turkish MNS for desktop computers (Yarman, 2010), no mobile application was found with this feature. The fact that the source codes of the developed software are owned by the researcher contributes to the possibility of developments in the near future. In the future, with the support of expert academicians in the field, a musical notation application featuring microtonal sounds and elements specific to Turkish music is planned to be developed and published, contributing to Turkish music education.



Data obtained in the study shows that three participant students started to place the notes more easily in the measure after using MNS. One of the most common mistakes made by students who have just started music education is to unwittingly place extra or missing notes or rests in the measure. While notating using a software, the student is, in a way, under the supervision of a teacher. When a note is placed in the measure in the missing beat, the software will automatically fill that area with a rest, or when a note is placed in the extra beat, it will warn the user. During software-supported notation, students are unconsciously informed on how to notate basic notes (clef drawing, sharp-flat order, distance of notes from each other, drawing figures, etc.).

Although numerous music students seek online information already available in their classes, most of this information is filled with inadequacies and unacceptable principles (Okeke, 2020). Therefore, music education applications developed by an educator, such as MNS, are of immense importance in the music education field. Moreover, as MNS is easily accessible, free, does not require a computer and is mobile imply that it can be made available to several primary school students via tablets. Furthermore, integrating this application into theory and composition classes in undergraduate music departments and other relevant lifelong learning programs is both conceivable and recommended. In the future, a free version of MNS developed for smartboards will be published on Microsoft Store (2022), thereby making smartboards a device that can be used to make music classes interactive and presenting an alternative to using PDF files or videos. Notating melody, composing and sight-singing exercises on notation applications will undoubtedly contribute to improving students' skills. Music education applications that do not have melody notation and display features lack many important aspects, such

as melodic dictation and melodic error detection. Numerous mobile music education applications, such as MNS, allow students to develop their musical skills at their own pace and in their comfort zone, without worrying about failure.

### *1. Limitations of the Study*

This study is subject to some significant limitations. The fact that the study group within the scope of the research consisted of only 23 individuals (21 students and 2 teachers) and that the analyses were conducted using a qualitative approach may lead to the findings of the study being unsuitable for generalization. Although the students stated that MNS enhanced some musical skills, making definitive conclusions without carrying out a quantitative data analysis process may be risky. Therefore, it is believed that in future studies, the use of quantitative research models to more clearly reveal the potential benefits of MNS would be beneficial. The data obtained from this study consist of the views of students and teachers. Apart from that, the researcher did not engage in any observation or document collection activity. It is recommended that future case studies on MNS be designed in a triangulated manner and that a thick, rich, and contextual description be achieved by collecting data of various types as much as possible.

### *2. Crucial Permissions: Ministry of National Education and Ethical Review Board*

In the scope of the study, prior to implementation, necessary applications were made to the 'Scientific Research and Publication Ethics Committee of Sivas Cumhuriyet University Rectorate (Referance Number: E-60263016-050.99-203152)' and the 'Provincial Directorate of National Education in Sivas Governorship (Referance Number: E-92255297-605.01-48375872)' to obtain research permission and ethical committee approval.

# Akıllı Telefonlar için Müzik Notasyon Yazılımı: Eğitsel Amaçlar Doğrultusunda Geliştirilmiş Bir Mobil Uygulama

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**Özet**

*Bu çalışmada, mobil öğrenmenin avantajları göz önüne alınarak, Unity oyun motoru üzerinde ücretsiz bir müzik notasyon yazılımı (Müziksel Kulak Eğitimi – Teori) geliştirilmiştir. MNY, kullanıcılara sanal sınıflar aracılığıyla ezgiler oluşturma, kaydetme, düzenleme, dinleme ve paylaşma olanağı sunar. Araştırmanın çalışma grubu, Türkiye'nin İç Anadolu Bölgesi'nde bulunan bir güzel sanatlar lisesinde görev yapan 2 öğretmen ve 21 öğrenciden oluşmaktadır. Batı müziği teorisi ve uygulaması dersinin bir parçası olarak öğrenciler, 4 haftalık bir süre boyunca öğretmenlerin rehberliğinde kişisel akıllı telefonlarında MNY'yi ders sırasında ve ders dışında kullanmışlardır. Uygulamanın ardından, öğrenciler ve öğretmenlere, MNY hakkındaki görüşlerini elde etmek amacıyla yarı yapılandırılmış bir görüşme formu uygulanmış ve elde edilen veriler kullanılarak içerik analizi gerçekleştirilmiştir. Analiz sonrasında katılımcıların MNY ile ilgili görüşlerinin genellikle olumlu olduğu ortaya konulmuştur. Öğrenciler, MNY'yi kullanarak solfej, dikte ve besteleme gibi birçok alanda egzersizler yapabilmişlerdir. Yazılımın sanal sınıf özelliği sayesinde öğretmenler, solfej ve dikte melodilerini internet aracılığıyla öğrencilerle paylaşabilmiş ve öğrenciler sınıf dışında ödevlerini yapabilme imkanı bulmuşlardır. Elde edilen veriler ve alanyazın incelemesi doğrultusunda aşağıda bazı öneriler sunulmuştur: Eğitmenler, mobil uygulama mağazalarındaki güncel müzik eğitimi uygulamalarının farkında olmalıdır. Müzik eğitimi araştırmacıları, müzik eğitimi uygulamalarının geliştirilmesi üzerine ortak projeler gerçekleştirmek için teknoloji uzmanlarıyla işbirliği yapmalıdır. Kurumsal yöneticiler, öğrenci ve öğretmenlerin 'Müziksel Kulak Eğitimi – Teori' gibi benzer uygulamaları kullanmalarını teşvik ederek gerekli altyapının oluşturulmasında öncü olmalıdır.*

**Anahtar kelimeler:** *Müzik notasyon yazılımı, Mobil uygulama,Mobil öğrenme,Müzik eğitimi,Durum çalışması*

***E-Uluslararası Eğitim Araştırmaları Dergisi***

*Cilt: 14, No: 5, ss. 222-242*

*Araştırma Makalesi*



*Gönderim: 2023-08-24*
*Kabul: 2023-09-26*

**Önerilen Atıf**

Özgül, Y. (2023). Akıllı telefonlar için müzik notasyon yazılımı: Eğitsel amaçlar doğrultusunda geliştirilmiş bir mobil uygulama, *E-Uluslararası Eğitim Araştırmaları Dergisi,* 14 (5), 222-242. DOI: https://doi.org/10.19160/e-ijer.1348703

## Genişletilmiş Özet

***Problem:*** Eğitim, bireyde; yetenek ve yeterliğini esasa alarak, kendisi, toplumu ve evrenseli dikkate alan bilişsel, devinşsel ve duygusal oluşum ve değişimleri gerçekleştirmek sürecidir. Bu sürecin içeriği toplum/insan ve doğanın bilgisini kapsar. Toplum veya insana dair olan bilginin bir boyutu da genel olarak sanatın özel olarak da müziğin bilgisidir (Toprakçı, 2016). Okul öncesi dönemden itibaren başlayan müzik eğitimi, yükseköğretime kadar devam eden bazen zorunlu bazen seçmeli eğitim süreçlerinden biridir. Uçan'a göre (1997) müzik eğitimi, bireye kendi yaşantısı yoluyla amaçlı olarak belirli müziksel davranışlar kazandırma sürecidir. Çocukta müziğin eğitsel amacını gerçekleştirmek için öğretmenler çeşitli yer, yöntem, teknik, araç ve gereçler kullanırlar (Kaptan, 2009; (Kurtuldu ve Kubaliç, 2023; Terzioğlu, 2023).

Müzik Notasyon Yazılımları (MNY), kullanıcılara müziksel pasajların görsel ve işitsel çıktılarını sunar. Bu özellikler, MNY için en basit (eğitim amaçlı) kullanımdan, en profesyonel olanına (performans amaçlı) kadar geniş bir uygulama yelpazesi sunmuştur. Bu alanda önde gelen yazılım programlarından biri, masaüstü ve dizüstü bilgisayarlarda çalışan Finale (2023) müzik notasyon yazılımıdır. Gorgoretti (2019) tarafından yapılan bir çalışma, öğrencilerin Garageband, Cubase ve Cakewalk gibi diğer notasyon yazılım programlarına göre Finale'yi daha sık tercih ettiklerini göstermiştir. Villani (2014), birçok müzik eğitimcisinin, müzik notasyon yazılımlarını (MNY) sınıflarında kullandıklarını belirtmektedir. Sunmuş olduğu fırsatlar, MNY'yi sınıf içi ve sınıf dışı ortamlarda müzik eğitimi için etkili bir araç haline getirmektedir. Son yirmi yılda teknoloji; günlük yaşamın bir parçası olacak kadar mobil, taşınabilir ve internete bağlı hale gelmiştir (Baran, 2014). Mobil akıllı telefonlar, internet bağlantılarıyla birlikte, müzik eğitimcileri için eğitim sürecinde birçok fırsat sunmaktadır. Sosyal medyada bulunan eğitim videoları aracılığıyla öğrenciler, müzik becerilerini geliştirebilirler (King & Prior, 2019) ve Covid-19 pandemisi bağlamında sanal sınıf odaklı çevrimiçi video konferanslar, müzik derslerini uzaktan yapmak için kullanılabilir. Müzik öğretimini eğlenceli hale getirmenin başka bir yolu ise sınıfta mobil cihazlar için geliştirilen oyunları kullanmaktır. Oyunlar, müzik eğitiminde görece yeni bir araçtır (Pierce et al., 2020) ve genç öğrencilerin müziksel becerilerini geliştirmelerine yardımcı olmak için önemlidir (Ji, 2016; Paule-Ruiz et al., 2017). Akıllı telefonların dokunmatik ekranı ve benzeri işlevleri, eğitim amaçlı oyunlar için mükemmel bir ortam sağlar. Mobil öğrenmenin sunabileceği potansiyel dikkate alındığında, öğrencilerin çok farklı disiplinlerden gelen ihtiyaçları düşünülerek, eğitimcilerin mobil cihazları eğitim sürecine entegre etmedeki rolleri daha da önemli bir hale gelmiştir (Baran, 2014). Günümüzde mobil öğrenme; dil öğrenme, matematik ve müzik eğitimi dahil olmak üzere birçok eğitim alanında kullanılmakta olup, becerilerin geliştirilmesine yönelik özel fırsatlar sunmaktadır. Foti ve Mendez (2014), mobil cihazların yüksek öğretimde kullanımını entegre etmek için yeni stratejileri keşfetmenin gerekli olduğunu belirtmektedir. Bu nedenle, müzik eğitimcileri, mobil öğrenmeyi eğitime entegre etme konusunda önemli bir sorumluluğa sahiptir. Bu sorumluluk doğrulstusunda bu araştırmada akıllı telefonlarda çalışmak üzere bir müzik notasyon yazılımı geliştirilmiş ve bu yazılım, araştırmacı tarafından GooglPlay ve AppStore mağazalarında yayınlanan "Müziksel kulak eğitimi - teori" isimli uygulamanın bir alt özelliği olarak tüm dünyanın kullanımına ücretsiz olarak sunulmuştur. Bu yazılım ile ezgi yazma, dinleme, kaydetme ve kaydedilen ezgileri sanal sınıflar aracılığı ile internet üzerinden diğer kullanıcılar ile paylaşma işlemleri yapılabilmektedir. Yapılan bu çalışma, geliştirilen yazılım hakkında öğretmen ve öğrenci görüşlerinin ortaya çıkarılmasını amaçlamaktadır. Bunlara bağlı olarak araştırmanın problem cümlesi aşağıdaki gibidir;

"Geliştirilen müzik notasyon yazılımı hakkında öğretmen ve öğrenci görüşleri nasıldır?"

***Yöntem:*** Bu çalışmada, nitel araştırma yöntemlerinden biri olan durum çalışması modeli kullanılmıştır. Durum çalışması modeli, değerlendirme araştırmalarında kullanılan önemli bir yöntemdir (Aytaçlı, 2012). Creswell (2007), durum çalışması modelini, bir veya daha fazla olayın derinlemesine incelendiği, bu olaylarla ilgili temaları ve alt temaları ortaya çıkarmak için çeşitli veri toplama araçlarını kullanan nitel bir yaklaşım olarak tanımlarken, Subaşı ve Okumuş (2017) ise durum çalışmasını veri toplamak ve gerçek dünya olaylarını incelemek için sistematik bir yöntem olarak karakterize etmektedir. Bu çalışmada, durum, geliştirilen yazılım (MNY) iken temalar ise bu yazılım hakkındaki öğrenci ve öğretmen görüşleridir. Araştırmanın çalışma grubu, amaçlı örnekleme yöntemlerinden biri olan homojen örnekleme yöntemi kullanılarak belirlenmiştir. Bu yöntemde, araştırma sorunu ile ilgili homojen bir alt grup seçilir (Baltacı, 2018). Araştırma sorusuna uygun olarak, çalışma grubu, Türkiye'nin Orta Anadolu

Bölgesi'nde bulunan bir Güzel Sanatlar Lisesi'nde çalışan 2 müzik öğretmeni ve aynı okuldan 2021-2022 akademik yılının bahar döneminde katılımcı öğretmenler tarafından verilen batı müziği ve teorisi dersini alan 9. ve 10. sınıf öğrencilerinden (n=21) oluşmaktadır. Öğrencilerin ve öğretmenlerin MNY yazılımı hakkındaki görüşlerini toplamak amacıyla iki yarı yapılandırılmış mülakat formu geliştirilmiştir (Ek 1). Bu formlar aşağıdaki verileri elde etmeyi amaçlamaktadır:

- MNY'nin sınıf içi ve sınıf dışı kullanım alanları.
- MNY'nin öğrenciler ve işlenilen ders için potansiyel faydaları.
- MNY'nin uygulanabilirliği.
- MNY kullanımı sırasında karşılaşılan sorunlar.
- MNY hakkındaki veli görüşleri.
- Sanal sınıf özelliğinin sunduğu fırsatlar.

Uygulama sürecinde, öğretmenler tarafından verilen dersin yürütülmesi sırasında araştırmacı tarafından öğretmenlere herhangi bir yönlendirme yapılmamıştır. Uygulama, haftada iki saat olarak verilen batı müziği teorisi ve uygulaması dersinin bir parçası olarak toplamda dört hafta boyunca gerçekleştirilmiştir (MEB, 2018). Uygulama süresince ders yütücüsü öğretmenler, öğrencilerin sınıf içinde ve dışında MNY'yi aktif olarak kullanmalarını sağlamışlar ve müfredatta belirtilen öğrenme çıktıları ile ilgili çeşitli beceriler kazanmalarına yardımcı olmaya çalışmışlardır. Uygulama sonrasında, araştırmacı tarafından geliştirilen yarı yapılandırılmış formlar öğretmenlere ve öğrencilere uygulanarak MNY hakkındaki görüşleri elde edilmiştir. Çalışmadan elde edilen veriler üzerinde içerik analizi yapılmıştır. Mülakat formlarındaki her soruya verilen yanıtlara göre kodlar oluşturulmuş ve her soru için çalışmanın bulgular bölümünde bir örnek katılımcı görüşü sunulmuştur. Örnek katılımcı görüşleri, katılımcıların adları anonimleştirerek ve etik prensipler göz önünde bulundurarak sergilenmiştir.

***Sonuçlar ve Öneriler:*** Bu araştırmada yer alan çalışma grubu, batı müziği ve teorisi dersini almakta olan güzel sanatlar lisesi öğrencilerden ve bu dersin yürütücüsü olan iki öğretmenden oluşmaktadır. Öğrenciler MNY'yi 4 hafta boyunca ders içi ve ders dışı ortamlarda kullanmış ve bu sürenin sonunda çalışma grubuna yarı yapılandırılmış görüşme formu uygulanmıştır. Geliştirilen bu görüşme formu, çalışma grubunun MNY hakkındaki görüşlerini elde etmeyi amaçlamaktadır. Elde edilen veriler, öğretmenlerin genellikle öğrencilere notasyon ekranındaki solfej ve dikte egzersizlerini yaparken rehberlik sağladıklarını göstermektedir. Uygulamanın çevrimiçi ezgi paylaşma özelliği sayesinde öğretmenler, akıllı telefonları üzerinden solfej ve dikte ezgileri oluşturup bu ezgileri sanal sınıflar aracılığıyla öğrencilerle paylaşabilmişlerdir. Öğrenciler, bu özelliği kullanarak solfej ve dikte sınavlarına hazırlık yapmışlardır. Öğrenciler, genellikle solfej egzersizlerini uygulama üzerinde solfeji dinlerken notasyon ekranındaki notaları gözlemleyerek ve bunları anında tekrar ederek yapmışlardır. Elde edilen görüşler, uygulama üzerinde ezgileri dinleyen öğrencilerin; tempoyu ayarlama, gerçek zamanlı bir yeşil çizgi kullanma, birim vuruşları gözlemleme ve perdeleri tanımlama yeteneğine sahip olduklarını ifadeetmektedir. Bu konuda yapılan başka bir çalışmada da (Prasso, 1997), bilgisayar ortamında koro ezgilerini yazma ve dinleme işleminin öğrencilerin deşifre şarkı söyleme başarısına önemli katkılar sağladığı gözlemlenmiştir. Elde edilen veriler, öğrencilerin ödevlerini tamamlamanın yanı sıra, eğlence amaçlı da uygulamayı kullandıklarını göstermektedir. Besteleme, önceden notaları bilinen bir ezgiyi yazma veya bilinen bir melodiyi dikte etme, bu aktivitelerden bazılarıdır. Örneğin bir öğrenci, Fenerbahçe marşını notaya almaya çalıştığını ve bunu yaparken çok eğlendiğini belirtmiştir. Ayrıca veriler, öğrencilerin ebeveynlerinin de notasyon uygulamasına olumlu bir tavır sergilediğini göstermektedir. Bir katılımcı öğrenci, ebeveynlerinin sürekli olarak uygulamayı boş zamanlarında kullanmalarını istediğini ifade etmiştir. Bu alandaki çalışmalar, ebeveynlerin çocuklarının akıllı telefon kullanımına yönelik temkinli olduklarını (Radesky vd., 2016; Al-Jarrah vd., 2019) ancak bu teknolojiler eğitsel amaçlarla kullanıldığında olumlu bir tavır içerisinde olduklarını göstermektedir (Özdamlı & Yıldız, 2014). Çalışmadan elde edilen veriler, üç katılımcı öğrencinin MNY kullanmaya başladıktan sonra notaları ölçü içinde daha kolay yerleştirmeye başladığını göstermektedir. Müzik eğitimine yeni başlayan öğrenciler tarafından en sık yapılan hatalardan biri, bilinçsizce bir ölçü içerisinde fazla veya eksik uzunlukta notalar yazmaktır. Bir yazılım aracılığıyla notaya alma işlemi, öğretmen ile notaya alma işleminden pek de farklı sayılmaz. Ölçü içerisinde eksik uzunlukta nota yazıldığında veya ölçü içerisine sığamayacak kadar uzun notalar konulduğunda yazılım otomatik olarak uyarı verecektir. Ayrıca yazılım destekli notaya alma sırasında öğrenciler, farkında olmadan temel notasyon kuralları hakkında da bilgi sahibi olurlar (anahtar çizimi,

diyez-bemol sırası, notaların birbirine olan mesafesi, şekilleri çizme vb.). Pek çok müzik öğrencisi sınıflarında zaten mevcut olan çevrimiçi bilgilere ihtiyaç duysa da bu bilgilerin çoğu yetersizlikler ve kabul edilemez ilkelerle doludur (Okeke, 2020). Bu nedenle, MNY gibi bir eğitimci tarafından geliştirilen müzik eğitimi uygulamaları, müzik eğitimi için büyük öneme sahiptir. Ayrıca, kolayca erişilebilmesi, ücretsiz olması, bir bilgisayara ihtiyaç duymaması ve taşınabilir olması, birçok öğrencinin MNY'ye rahatlıkla ulaşabilmesine imkan verir. Bunların yanı sıra uygulamanın lisans müzik bölümlerindeki teori ve kompozisyon derslerine ve diğer ilgili sürekli öğrenme programlarına entegre edilmesi tavsiye edilmektedir. Gelecekte MNY'nin akıllı tahtalar için geliştirilen ücretsiz bir sürümünün Microsoft Store (2022) üzerinde yayınlanması ile akıllı tahtalar, müzik derslerinde PDF ve video görüntülemenin yanı sıra interaktif bir nota yazma ve seslendirme aracına dönüşebilir. MNY üzerinde nota yazma, besteleme ve deşifre çalışmaları, şüphesiz ki öğrencilerin becerilerinin geliştirilmesine katkı sağlayacaktır. Ezgi yazma veya gösterim özelliği bulunmayan müzik eğitimi uygulamaları, ezgisel dikte ve hata tespiti gibi birçok önemli egzersizden yoksun kalacaktır. MNY gibi çok sayıda mobil müzik eğitimi uygulaması, öğrencilerin müzik becerilerini kendi hızlarında ve kendi konfor alanlarında, başarısızlık endişesi duymadan geliştirmelerine olanak tanır.

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## Appendix – 1

***Interview Form Questions for Students***

1- What are the benefits of notation application for you? Please explain.
2- For what purposes did you use the notation application? Please explain.
3- Would you like to continue using the musical notation application during the classes in the future? Please explain.
4- How did your parents react when you used the notation application at home? Please explain.
5- What are the problems you experienced while using the notation application?
6- What are your suggestions to improve the notation application?

***Interview Form Questions for Teachers***

1- What are the benefits of notation application for the students and how does it contribute to your class? Please explain.
2- For what purposes did you use the notation application in the classroom (smartboard and students' individual phones)?
3- For what purposes did you allow students to use the notation application outside the classroom?
4- What benefits did the virtual classroom feature of the application offers in your class?
5- Did the notation application trigger a change in students' attitudes towards the course? If so, please explain.
6- What are the problems you experienced while using the notation application?
7- What are your suggestions to improve the notation application?