

## 앱인벤터를 활용한 초등학교 리코더 앙상블 학습용 애플리케이션 개발 연구

### A Study on the Development of an Application for the Learning of Recorder Ensemble in Elementary School Using App Inventor

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**Abstract** The purpose of this study is to design and develop a recorder duo educational app for elementary school students using App Inventor. The app developed in this study provides sound sources of recorder duets, and piano accompaniment in a slow tempo for practice and a fast tempo for performance. Total 11 pieces for recorder duets were chosen from music textbooks for grades 3-6 of elementary school. Using these sound sources, students can develop their "inner hearing" to imagine or listen to the sounds of counterparts while playing their own part. In addition, evaluating the developed app by four pre-service elementary school teachers in terms of content, educational utility, performance, and functionality was also executed in the study. Through this study, it is expected that teachers will be able to develop an app for learning recorder duets as needed, increasing educational efficiency and giving students opportunities for self-directed learning.

**Key words:** App Inventor, app development, block-based coding, recorder duet, inner hearing

**초록** 본 연구의 목적은 앱 인벤터를 활용하여, 초등학생을 위한 리코더 2중주 교육용 앱을 설계하고 실제 개발하는데 그 목적이 있다. 본 연구에서 개발하는 앱에서는 초등학교 3~6학년 음악교과서에 수록된 리코더 2중주를 위한 11개의 악곡의 효율적인 학습을 위하여 Part 1, Part 2 그리고 교사반주 음원을 각각 연습용 느린 템포와 연주용 빠른 템포로 제공한다. 이를 통하여 학생들은 본인의 성부를 연주하며 다른 성부의 소리를 상상하거나 들을 수 있는 내청 능력을 개발할 수 있게 된다. 또한 블록 코딩 과정으로 개발된 앱의 내용적, 교육적 효용성, 성능 및 기능적 측면에서 예비교사 4인을 통해 평가를 받는 과정도 연구에 포함되었다. 이 연구를 통해, 현장에서 교사가 그 필요에 따라 리코더 2중주 교육을 위해 앱을 직접 개발함으로써, 교육적 효율성을 높이며 학생들에게는 자기주도적 학습의 기회가 주어지기를 기대한다.

**주제어:** 앱 인벤터, 앱 개발, 블록 코딩, 리코더 2중주, 내청

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# I. Introduction

## 1. Necessity and Purpose

The Fourth Industrial Revolution (4IR) is the fourth important era in human history since the early 18th century, and is the next generation of industrial revolution, which is a major change in the 21st century. The prevailing prediction is that the future world will continue to connect billions of people to virtual worlds such as the Web through integration with new technologies such as big data, artificial intelligence, robotics, and the internet of things, and dramatically improve business and organization operations (Marr, 2016; Kwon & Jung, 2022).

In particular, in the field of education, as devices have expanded from PC-oriented to mobile media platforms along with tablet PCs and smart phones, learning has become possible without restrictions on time, place, and device. Recently, efforts have been made in all subjects to realize personalized education using artificial intelligence, big data, and metaverse. Such a rapid change of paradigm of education and environment has also affected overall music curriculum.

In Korea, the 2015 revised curriculum was reorganized and applied from the existing computer-oriented education content to the basic software education content in 5th-6th grades with the aim of cultivating computing thinking (CT) to solve real life problems. In order to improve students' creativity and problem-solving skills, software education applies various CT-based software education methods such as unplugged education, block-based programming education, and physical computing (Sung, 2016). The 2022 revised curriculum, currently under development, is expected to further strengthen learners' thinking competency through software education, doubling elementary and middle school information classes (Ministry of Education, 2015; Ryu & Han, 2015).

In addition, the COVID-19 pandemic has contributed to the rapid growth of the edu-tech industry by accelerating the development of Information and Communications Technology (ICT) utilization capabilities and application of online activities. Edu-Tech refers to technology in which the educational service industry combines with ICT technologies such as artificial intelligence (AI), virtual reality (VR), and augmented reality (AR) to provide a different learning experience. Beyond the education in which one teacher provides the same curriculum to a large number of students, it has become possible to provide customized educational content to each student through AI. In addition, it has become possible to develop an educational medium

in which classroom as a physical learning space can be provided beyond time and space.

Until now, we have become familiar with an educational environment that utilizes various educational apps through smart devices. Furthermore, we are in an era where everyone develops apps and uses them as an educational medium. Recently, Google and Massachusetts Institute of Technology (MIT) are providing an open source web application called "App Inventor" so that anyone can easily receive computing education. App Inventor is a program that allows anyone, including children, to develop personalized apps by assembling blocks pre-made with a mouse similar to touching Lego blocks instead of complex computer C language.

It is true that using existing apps can only indirectly help learning, but there is a narrow choice in finding content that can be directly linked. In addition, in order to provide feedback, there are limitations in that the cost and time are wasted and smooth feedback is not achieved by requesting a professional programmer to modify the content through bulletin boards, e-mails, and telephones(Yoo, 2008; Kwon & Jung, 2022). Therefore, in recent years, research has been conducted to develop an app by directly selecting the learning contents required by instructors in the educational field.

In particular, in the case of arts and physical education, various problems are presented, such as lack of teachers' expertise in practical activities, lack of teaching-learning methods and materials, students' reluctance to express themselves, lack of objectivity in evaluation, and difficulty in class management (Kwon et al., 2021; Kim, 2009; Kim, 2003; Oh, 2016). The development of an app that provides teaching materials using smart devices can be considered as an alternative to overcome these difficulties in practical guidance. In the case of educational apps using smart devices, they can be used anywhere beyond the classroom, and can contain personalized learning materials tailored to each student's level.

In music education, musical activities using virtual instrument apps are possible to overcome the limitations of classroom instruments, and many teaching strategies and studies have been conducted(Yang 2020; Lee, 2019; Lee, 2017; Kwon, 2020). On the other hand, research on developing apps by music teachers has been conducted rarely, and all of recent studies are using app inventory (Kim et al., 2020; Shin, 2019; Kwon & Jung, 2022).

The need for teachers to develop their own apps is raised so that students can easily use them with the learning content required in the class. This is a step further from creating and using a teaching and learning web page or blog online as "Learning Management System (LMS)," and the purpose is to increase learning efficiency by creating and utilizing apps that contains simple functions and contents needed for teaching and learning.

For example, if a customized educational app that provides instrumental music and piano accompaniment in various tempos according to the student level is developed, students can practice at home as well as in the classroom. In particular, in the case of studying instrumental ensemble such as recorder duo, students should be able to listen to the counter part as well as their own melodies. At this time, if there is an educational app that helps students hear and play not only the melody played but also their counterparts repeatedly, it can be a great help in developing students' listening ability. Additionally, students will become familiar with not only their part but also the piano accompaniment, so they can play with confidence.

The purpose of this study is to explore the possibility of developing teaching materials for effective instrumental learning along with enhancing teachers' digital literacy capabilities by creating educational apps that can be used for recorder ensemble learning in elementary music education using App Inventor program.

## **2. Methods and Procedures**

### **1) Methods**

Richey, Klein, & Nelson (2004) largely classified the form of developmental research into two categories: 'research type I', which focuses on the development process of the program, and 'research type II', which focuses on the generalization of the developed program. First of all, this study is the 'research type I' stage to explore the design process so that elementary school teachers can easily create apps for recorder learning using an authoring tool called an App Inventor.

Specifically, this study aims to design and develop a simple educational app that allows students to practice along with inner hearing ability in recorder duet of elementary music class. To this end, the process of uploading music scores and teacher demonstration necessary for students' recorder practice will be provided in detail as well as the design and coding process of the educational programming tool 'App Inventor.' This will contribute to the development of digital literacy of school music teachers so that they can apply not only to this project, but also to other similar educational app development. Subsequently, in the 'research type II' stage, the developed app is evaluated by the music education expert group to discuss how to use it in the field and the possibility of developing teaching materials for effective instrumental learning.

## 2) Selection of the contents in the app

Among the recorder duets in the music textbooks for grades 3-6 of elementary school, a total of 11 songs without copyright problems were selected as learning contents. Overview of the content such as, song title, key, difficulty, and publisher is as follows <Table 1>.

<Table 1> Contents of app for recorder duet

| Publisher | Repertoire                  | Key     | Level |
|-----------|-----------------------------|---------|-------|
| Mirean    | Canon 1                     | G major | Gr. 3 |
|           | Canon 2                     | G major |       |
|           | German folk song 1          | d minor |       |
| Chunjae   | Eine Kleine Nachtmusik      | C major | Gr. 4 |
| Kumsung   | Ode to Joy                  | G major |       |
| Mirean    | German folk song 2          | G major |       |
|           | Edelweiss                   | C major | Gr. 5 |
| YBM       | Chopsticks                  | C major |       |
|           | From the new world          | F major |       |
| Chunjae   | Magic bell                  | F major | Gr. 6 |
| Jihaksa   | Pomp and circumstance March | C major |       |

## 3) Procedures

A number of recorder duet pieces are in elementary school music textbooks, but there are no specific practice strategies for ensemble learning that involves listening to the counterpart and piano accompaniment simultaneously. The app developed in this study provides two voices of recorder. And piano accompaniment sound in a slow tempo for practice and a fast tempo for performance, respectively. Through these sound sources, students can develop their inner hearing ability to imagine or listen to the sounds of other parts.

The development of music education app using mobile devices has the advantage that students can self-direct practice regardless of where they are at home as well as in classrooms. This study aims to develop an app for teaching and learning materials that can be easily used in music classes using the *App Inventor*, a smart phone-based educational programming language that can be easily used even by non-majors. At this time, the production process and contents are designed so that anyone can easily access as developing contents to be

guided by elementary school teachers using free app authoring tools. In this study, the development process of the 'designer' part of the *App Inventor* and the 'block' part of the coding will be analyzed and shared in detail. This will provide literature to present the possibility of elementary school teachers developing app for music education on their own.

Specific research methods and procedures are as follows.

- ① A total of 11 recorder duet music that do not violate the copyright law were selected from elementary school music textbooks.
- ② Use the Musescore 3 program to produce recorder scores. In addition, considering the student's level, the recorder Part 1 & 2 are recorded in a slow tempo for practice and a fast tempo for performance, respectively.
- ③ Considering the quality level of the teacher's accompaniment, the researcher directly played the accompaniment with the acoustic *Yamaha* Grand Piano in the general music room instead of the mechanical sound, and recorded using Logitech Yeti Nano Microphone and PC recording program Audacity.
- ④ Develop a storyboard for learning content and activities shown in the user's mobile app. This is a basic task for designing 'designer' and 'block' two representative items when developing an app with an *App Inventor*. By specifying text, images, buttons, and media to be mounted on each screen, trial and error in the app development process can be minimized.
- ⑤ Using *App Inventor*, develop a 'designer' page that arranges items displayed on the user's mobile and a 'block' page that codes it.
- ⑥ Download the APK file for students to use in actual music classes.
- ⑦ The app development process and the teaching method using it are evaluated by 4 pre-service teachers. In addition, the possibility of developing new apps for effective instrumental learning and enhancing teachers' digital literacy skills will be discussed.

This study limits the subjects of the study to recorder duo music in textbooks for the 3rd to 6th graders published under the 2015 revised music curriculum. The sound source developed as a music teaching-learning material is produced as a general classroom instrument rather than a professional studio, so there may be limitations in sound quality. In addition, the app developed in this study is available for Android-based mobile or tablet PC.

## II. Literature Review

### 1. Developing Inner Hearing

The musical experience that students must acquire in an instrumental ensemble is the ability to play their own voices harmoniously with others. Recorders, which are frequently used in instrumental music classes in Korean elementary school, have the advantage of being portable and relatively easy to play. Recorder learning is presented not only for solo, but also for ensemble. However, the specific teaching strategy is insufficient. What students find particularly difficult when performing ensemble with others is listening to other parts. This can be overcome only when students practice listening to the other voice while playing the music alone.

In the mid-1800s, Lowell Mason (1792-1872), who contributed to the importance of music education in American public schools, also said that sound should be taught before symbols. The process of learning language and music is very similar (Birge, 1966). In order to acquire a language, we repeat hearing and speaking countless words before we learn to read and write. Even in music education, we listen and sing along to countless songs before reading and writing notes on the staff. At this time, in addition to the sounds that are actually heard and perceived, we can imagine and recall the previously learned sounds through inner hearing, and accumulate experiences to sing and play instruments.

Inner hearing is the ability to imagine sounds in one's mind and head without actually playing or singing. Just like when reading a book, it is necessary to be able to think of sounds and sing inwardly in order to make music, just like 'silent reading', where reading text inwardly without making a sound. Edwin E. Gordon (1927-2015) called this "audiation." Audiation is the ability to hear and manipulate sound in one's mind in the absence of any physical sound(Gordon, 1997). Audiation is to music what thought is to language (Gordon, 1999).

The importance of inner hearing is also frequently emphasized in his teaching methods by Z. Kodály, a representative music educator of the 20th century. Kodaly emphasized that the ability of inner hearing with one's head and mind without actually playing a musical instrument or singing is a basic ability that one must possess for free and progressive music activities (Cho, 2004). And he emphasized singing with his voice as a way to greatly develop this inner hearing ability.

## **2. Educational Effect of Teacher's Modeling and Piano Accompaniment Audio Source**

Inner hearing is an essential skill for performing ensemble where performers have to harmonize with others while listening to other people's music. If the students can practice while listening to the other part, they will be able to play without panic, remembering their counterpart in the actual ensemble. As much of instrumental learning is an activity that requires time and effort to practice alone, providing an auditory model that corresponds to a teacher's demonstration or accompaniment leads students to engage in practice with interest and motivation (Lancaster & Renfrow, 1995). In addition, in school where one teacher instructs many students at the same time, the use of the auditory model can reduce the teacher's work and contribute to the efficient practice. Music learning using the auditory model helps students learn to listen to music, enjoy it more, and practice it for a long time (Lacaster & Renfrow, 1995; Renfrow, 2000; Alexander, 1990).

With the development of technology, music education tools that provide auditory modeling have already existed for more than 30 years. In the 1990s, accompaniment MIDI sound sources were developed in the form of floppy disks or CD-ROMs. It has gradually evolved and currently downloads and uses music file data, or recognizes and plays music uploaded to YouTube as a QR code. Furthermore, music appreciation apps or educational apps containing auditory models are being released.

## **3. App Development for Music Education**

The use of smart phones or tablet PCs as a teaching and learning media has already flowed considerably into school music education. Smart phones can be used regardless of time and place, and communication between teachers and parents is easy. It is called a small computer in the palm of the hand, replacing computers in terms of function and being used in many areas of education because it can be shared by many people. In the past, e-learning using computer software or Internet communication was a big part, but recently, due to the popularization and use of smart phones, most programs are moving to m-learning using tablet PCs and smart phones.(Kim et al, 2020)

Contributing to the expansion of m-learning is the active development of apps in tablet PCs and smart phones. 'App' refers to various application programs provided on smart phones,



which are intelligent terminals that add computer support functions to mobile phones. In the past, music education through technology mainly consisted of digital pianos or activities that connected MIDI to a keyboard. In addition, for developing students' comprehensive musicianship, it was limited to use software or web site for music theory, sight reading, sight-singing and ear-training. However, due to recent rapid development of information and communication technology, various apps that can be directly used for actual school music education are being developed. In actual school music education, especially instrumental music activities are accompanied by difficulties such as the economic burden that may arise from the school's purchase of musical instruments and managing the musical instruments (Park, 2014). As a way to overcome this, research on using apps that provide sound sources such as gayageum, guitar, drum, recorder, samulnori, and ocarina is being actively conducted.

The COVID-19 pandemic, which has taken over the world since 2019, has accelerated the digital transformation of our daily lives at a tremendous pace. It has become common to use various smart phone apps as learning tools to increase educational effects, and it is time to produce simple apps that can be used not only by computer programmers but also by non-experts in their daily lives.

In the field of music education, a case study in which teachers develop educational apps directly linked to required learning contents is being presented. Shin(2019) developed an app for music appreciation and music theory using App Inventor. In line with App Inventor's slogan, "intuitive and visual educational programming tool that helps anyone, even non-professionals create," that App Inventor stands for, the 'text', 'button', 'vertical layout', and 'picture', 'Media' layout, etc., and a production method using block coding are presented. This app developed in the study can be used in middle school music theory classes, and it can actually be driven by the '*WeMusic*' app in the Google Play Store.

Through App Inventor program, Kwon and Jung (2022) actually designed and produced an app for instrumental music learning that helps the 3rd graders to practice recorders on their own. In this study, by explaining the coding process in detail to run the app, it provides a method for field teachers to develop and utilize the class app themselves.

### III. App Development for Elementary School Recorder Ensemble

#### 1. Design and Preparation Process

The first part to configure in App Inventor is 'designer' page. In the designer page, various elements of the user interface are placed on the screen, and properties of components can be specified. In addition, image and sound files can be uploaded. In this study, a total 11 songs in 14 screens are presented, among which the contents and structure of the storyboard composed of the designer page on screen 1 to 5 are as follows<Table 2>.

<Table 2> Examples of contents and structure for screen 1~5

| Screen # | User interface                            | Contents                                                                                        |
|----------|-------------------------------------------|-------------------------------------------------------------------------------------------------|
| 1        | Label<br>Image<br>Button                  | Name of app<br>App title image<br>Start, contents                                               |
| 2        | Label<br>Label<br>Label<br>Button         | Purpose of app<br>App creators<br>Contact info<br>Start, Contents, Next                         |
| 3        | Label<br>Button<br>Button                 | Contents<br>11 Repertoires<br>Start, Contents, Next                                             |
| 4        | Label<br>Image<br>Button+player<br>Button | Canon 1<br>Recorder duet score<br>Rec.1, Rec 2, Duet, Acc audio source<br>Start, Contents, Next |
| 5        | Label<br>Image<br>Button+player<br>Button | Canon 2<br>Recorder duet score<br>Rec.1, Rec 2, Duet, Acc audio source<br>Start, Contents, Next |

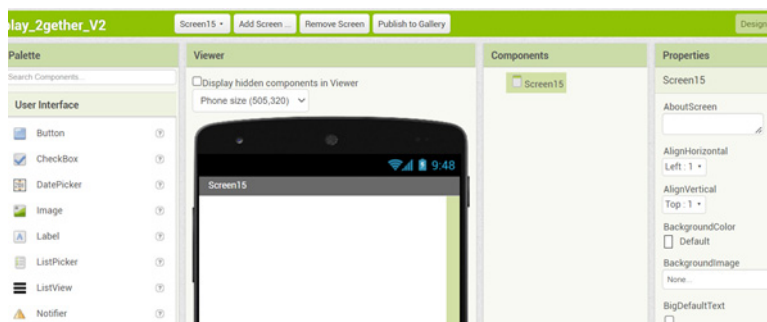
## 2. App Creation Process

### 1) Image and sound sources

After configuring the screen of the app, image data and sound source data to be uploaded to the app inventory 'designer' page are produced. In this study, total 11 songs were written with 'MuseScore3', a music notation software. This program enables to select an instrument and play a performance according to the arbitrarily selected tempo. In this study, for the recorder duet, scores and sound sources corresponding to recorder 1 & 2 are produced, respectively, and ensemble scores, sound sources, and accompaniment sound sources are prepared. Specifically, 8 sound sources are required for each song by setting ♩=80 for a slow tempo and ♩=100 for a fast tempo. Although this study suggested only two types of tempo, it can be presented in a more subdivided manner according to the needs of students.

### 2) Creating the designer page

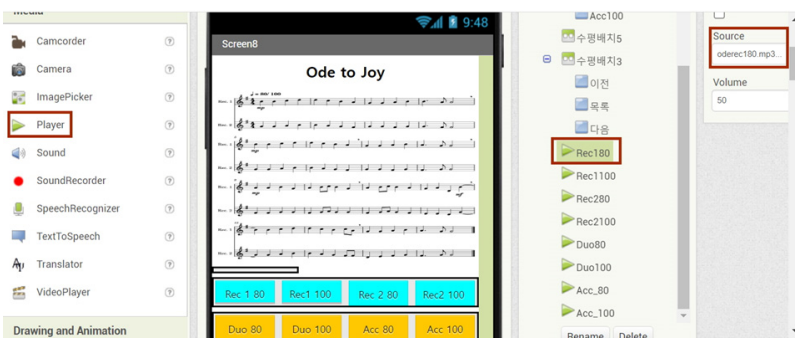
On the 'designer' page, it is possible to implement the screen that appears on mobile. Select a layout for screen composition from the left screen palette, select a user interface, and then select various menus to fill the configured screen and drag it to the viewer. The App Inventor 'designer' screen before work is shown in [Figure 1] below.



[Figure 1] Designer page on app inventor

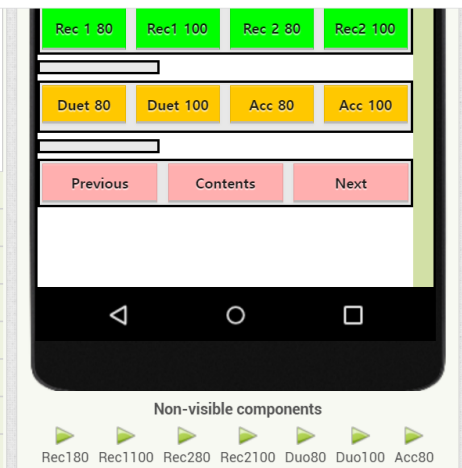
On the left side of the 'designer' screen, there are menus where items for the app screen can be placed. In this study, 'label', 'image', 'player', 'text box', and 'button' items were mainly used among the user interface menus. Users can use the uploaded sound source by clicking

the 'button'. Labels, text boxes, and buttons are dragged from the user interface to the viewer, and text is entered using the properties area on the right side of the designer screen. Since the developed app helps recorder playing, drag the 'player' from the media menu on the designer screen to the viewer, and upload the sound source from the properties. After composing the block menu, the clicking button leads to music playback. The following [Figure 2] is a scene where a sound source button is created on the designer screen and a sound source is inserted in the properties.



[Figure 2] Uploading audio source on designer page

As shown in [Figure 3], although it is not visible in the actual app, there are 8 sound sources that can be played when the button is tapped. The 8 sound sources include 2 different



[Figure 3] Unloaded audio source in 2 different tempos

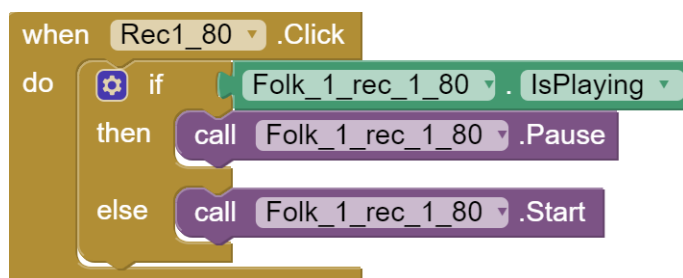
tempos of Recorder 1, 2 tempos of Recorder 2, 2 tempos of Recorder Duet, and two different tempos of piano accompaniment.

### 3) Creating block page

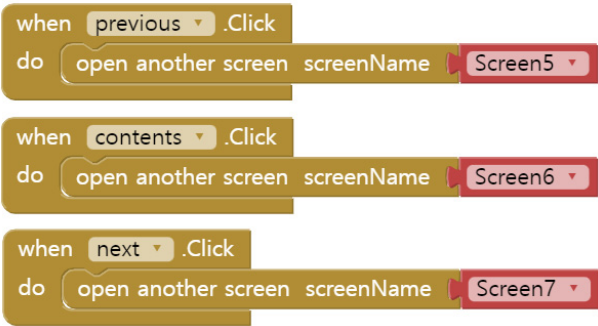
[Figure 4] and [Figure 5] are 'block' pages that works with coding to run the designed app on the 'designer' screen. "Coding" is synonymous with programming and refers to the process of inputting commands in a language that a computer can understand. In order to pause or start a sound source depending on whether the sound source is played by tapping the button to play the sound source, the following logical thinking process must be controlled. For this, the player is executed when the button is clicked by connecting the block "when button is clicked" and the block "whether or not a sound source is playing."

Furthermore, an if block is added to the 'when button click' block, and 'if the sound source is playing' is connected, then a block called 'stop playing the sound source' is created, and this time, press the button while the sound source is playing click to pause the sound source.

[Figure 4] is the coding for executing one button. If there are 4 player buttons with the same function on one screen, this coding needs to be made 4 times. And on each screen, 3 buttons for page shifting (previous, next, contents) are designed. [Figure 5] is an example of coding for page shifting.

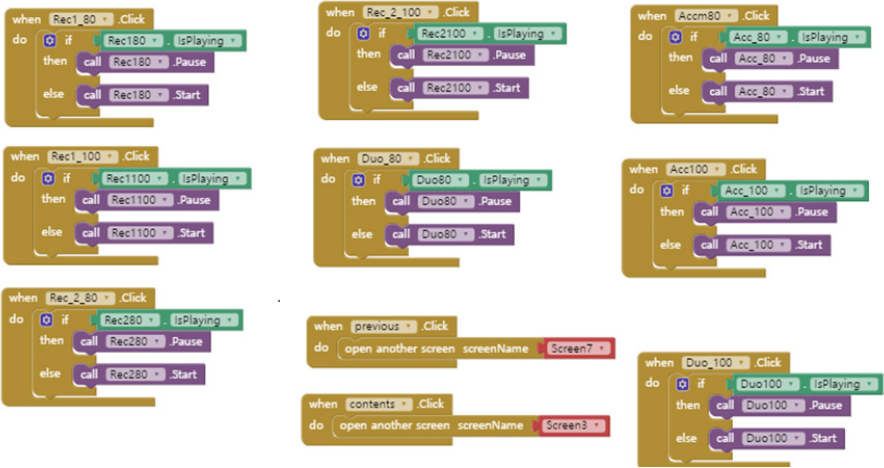


[Figure 4] Block coding page for button menu execution



[Figure 5] Block coding for page shift

Next, [Figure 6] is an example of block coding that combines the coding of 4 sound sources playback buttons and 3 page movement buttons that are presented to one screen.



[Figure 6] Block coding screen to execute [Figure 2]

The following is an example of a screen that actually shows mobile through design and coding on the designer and block pages [Figure 7].



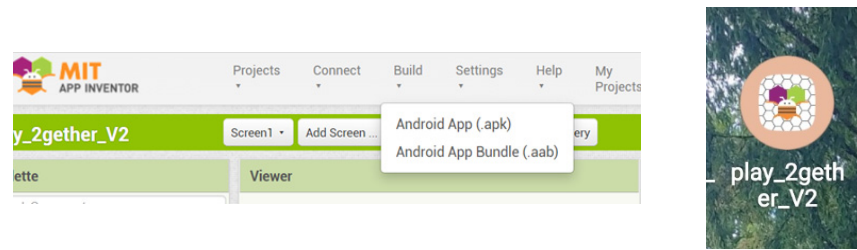
[Figure 7] The actual screen of the app seen on the smart device

#### 4) Creating APK file and sharing the app

In order to link apps made through PCs with smart devices, click AI Companion in the connect menu at the top of the App Inventor designer page, and use the provided QR code. Furthermore, in order to share this app with students, another QR code is needed, and the APK file must be downloaded first. In the Build menu at the top of the designer screen, click Android App (.apk)[Figure 8]. When the generated QR code is recognized by the smart device, the app is uploaded to the smart device. To register an app developed by Google Play, a developer registration fee of 30,000 won is required.

Access the site (<https://play.google.com/console/features>) and fill out the account information, app details store registration setting country and region selection, version review and

installation on the site. After that, when the downloaded APK file is uploaded, the app is released and can be shared with more people.



[Figure 8] Upper side of designer page & app icon on the mobile

5) Learning contents in the app

In the app developed in this study, recorder duet songs for grades 3-6 were presented for each screen. Sufficient practice process for each part will be required for the duet, and for this purpose, the sound source was produced with two different tempos. The piano sound source is also presented in two different tempos, so it can be used selectively. As such, through the app presented in this study, students can practice the part they want to play and the other part for the duet even in an offline situation. Since the piano accompaniment in this app is acoustic version rather than midi, it is meaningful in that it can provide students with an acoustically more aesthetic experience.

IV. Evaluation

To evaluate the educational applicability of the developed app in this study, a group interview was conducted for 90 minutes with 4 pre-service teachers at the university where the researcher works. Interviewees are currently in their senior year of university, and they have experience of compulsory learning of coding courses using 'Entry' program for more than 2 semesters while attending the university.

The developed app was downloaded to the smart device or mobile phone of the participants and they evaluated the content, educational utility, and functionality of the app. They were



also asked for consent to the recording of the interview. All the process was recorded on the researcher's mobile. After that, based on the transcription using the voice conversion program (clovanote.naver.com), the results of the analysis were divided into the content aspect, educational effectiveness aspect, and functional aspect of the app.

## 1. Content

The overall evaluation by pre-service teachers in terms of the content of the app was positive. First of all, the learning songs presented in the app were presented by level as a whole, from easy songs to more complex songs. In addition, it is believed that it is possible to play while listening to the counter melody, which helps to develop a sense of harmony, and it is possible to self-evaluate the performance by providing sample performances.

However, in the classroom, they said that it would be better to use a headset so that they do not interfere with each other, and if it is a long song, it would be good to design additional songs so that students can practice in-between sections. In particular, for the sound source built into the app, despite using the muse score, there was no mechanical sound, so it was comfortable to listen to, and there was an opinion that it would be better to be more subdivided in terms of tempo.

Regarding the piano accompaniment sound source recorded and uploaded by the researcher, opinion was offered that it would be a great help to students' musical expression as it is not an artificial electronic piano accompaniment. Also, there was an opinion that the phrasing could be expressed when playing the recorder by revealing the musical breathing through the acoustic piano accompaniment. In particular, it was said that the fact that the teacher recorded the accompaniment can strengthen the learning motivation of the students. The following is a part of the interview <Table 3>.

<Table 3> Interview on the content of the app

| # | Question                                                                               | Answer                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                     |
|---|----------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Are the songs presented by level?                                                      | "The first song is a relatively simple melody and from then on, it comes out in a more complex order, so I think the presentation by level was well done." (p. 1)                                                                                                                                                                                                                                                                                                                                                                                                                                                                          |
| 2 | How did you practice the recorder duet songs before?                                   | "It seems that I only focused on each part and practiced and thought about how to play that part correctly. I think there were very few opportunities to think about the harmony of sound." (p. 1)<br>"Because there was no so-called 'sample playing', I played roughly without knowing whether the chord was right or wrong." (p. 2)<br>"There were many cases where I practiced each voice by myself and made a lot of mistakes when I went to practice." (p. 3)<br>"When I practiced by myself, I recorded one part and then played along with it. The biggest problem was that I didn't know exactly if I was wrong or right." (p. 4) |
| 3 | What are the strong and weak point of practicing recorder duet with the developed app? | "I thought that the strong point is that I can now listen to the voices different from the voice I sang together and separately. But, if without headset, it's good for personal practice at home. I think it would be good to use for distance learning." (p. 2)<br>"For long and difficult music, there is the inconvenience of having to go back and practice from the beginning even if you want to practice in the middle. Therefore, if the sheet music is long, it would be good if the sound source would be provided by cutting it into sections so that we could practice partly." (p. 3)                                        |
| 4 | What about the tempo and tone expression of the recorder sound source?                 | "You said that you didn't actually record the recorder, but used the muse score, but there was no objection to the sound at that time, and I was very satisfied." (p. 1)<br>"I couldn't hear the sound of the machine, so it was comfortable to listen to." (p. 2)<br>"It would be nice if the tempo could be more varied." (p. 3)                                                                                                                                                                                                                                                                                                         |
| 5 | Are you satisfied with the tone or expression of the piano?                            | "The difference between the sound source played by the teacher on the acoustic piano was clearly felt. I think that the fact that our teacher's performance was recorded will have a huge impact on children's interest." (p. 2)                                                                                                                                                                                                                                                                                                                                                                                                           |

p. 1=participant 1, p. 2=participant 2, p. 3=participant 3, p. 4=participant 4

## 2. Educational Effect

Participants also gave positive evaluations on educational effectiveness. Above all, they said that it would allow students' self-directed practice, and it would be useful not only in the classroom, but also distance learning at home. In particular, it is possible to improve

students' steady beat and accurate sound performance through sample sound sources. The acoustic piano accompaniment actually played by the teacher could also allow the listener to hear the phrases, so it was expected that the musical expression would be improved.

All of the pre-service teachers 1 to 4 answered that they were willing to fully use them in the field in the future. However, since the intention of this study is to make and use the app necessary for the music class by the teachers themselves, problems and suggestions for the app making process were presented. For example, when creating an app for recorder practice, a way to collaborate has been proposed. When a teacher is not good at playing the piano, a teacher who can play the piano records a sound source with the help of a fellow teacher or student who can play the piano, and a teacher who can code develops the app.

In addition, when practicing recorder duet, it was considered that it could help develop inner hearing. Students are generally familiar with the soprano melody, but lack an understanding of the alto part. Therefore, it will be of great help in training to listen to counter melody when practicing alto part while playing the soprano part sound source using the developed app. The following is part of the interviews with pre-service teachers <Table 4>.

<Table 4> Interview on the educational effect of the app

| # | Question                                                                      | Answer                                                                                                                                                                                                                                                                                                   |
|---|-------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Is there any possibility of using this app in elementary school music class?  | "These days, schools provide each student with a tablet, so it's larger than the screen of a smart phone, making it much easier to read sheet music." (p. 3)<br>"It would be better to use it for home practice than to practice wearing earphones to listen to the counter melody aloud." (p. 2 & p. 4) |
| 2 | Will this app improve the recorder performance of elementary school students? | "Actually, the thing that elementary school students do the least is constant beat. But when a song is playing on the recorder app itself, you can't get out of that beat. So it's a great help for regular beat practice." (p. 2)<br>"Sample performances helps to improve recorder playing." (p. 4)    |
| 3 | Can it induce self-directed learning?                                         | "If you indicate the level of difficulty for each song, I think students will want to take on a challenge." (p. 3)<br>"Adding 'self-evaluation' at the bottom of the screen to how well the students did themselves seems to help motivate them." (p. 4)                                                 |
| 4 | Is this app developed effectively to practice listening to the counterpart?   | "When playing the soprano part sound source and practicing the alto part, it seems to be very helpful in learning to listen." (p. 2)                                                                                                                                                                     |

3. Functions

In the meantime, teachers have created personal blogs or classroom web sites to upload music concepts that students need to learn or music sources to listen to, and use them as educational materials. Now it is an era where anyone can easily create an app. Participants presented the following advantages about using music learning content in an app rather than uploading it to a web page or blog. First of all, it has excellent accessibility and can be used even in an environment without Wi-Fi. In addition, exposure to harmful sites or advertisements is relatively low, and manipulation is easy. The following is a part of the interview on the performance and functional aspects of the app <Table 5>.

<Table 5> Interviews on the performance and capabilities of the app

| # | Question                                                                     | Answer                                                                                                                                                                                                                                                                                                                                                                                                             |
|---|------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| 1 | Is the developed app easy to use for elementary school students?             | "For younger students, I think the terms 'slow duet' and 'fast duet' are much easier to understand intuitively than the terms 'practice duet' and 'performance duet'." (p. 3)                                                                                                                                                                                                                                      |
| 2 | Are there any functional problems in running the app?                        | "There is no major inconvenience, but since the buttons to play and stop sound sources are shared, there is no button to pause." (p. 2)                                                                                                                                                                                                                                                                            |
| 3 | Comparing using app and blogs, which tool is convenient for students to use? | "First of all, the app is highly accessible. While you have to click several steps to register and log in to enter the web site or blog, the app can be accessed with a single tap and can be used even in an environment without Wi-Fi." (p. 1)<br>"While accessing web pages or blogs and being exposed to harmful sites or advertisements, the app is not, so I think it is more suitable for learning." (p. 3) |

V. Conclusion

This study is meaningful in exploring the possibility of developing teaching materials for effective instrumental learning along with enhancing teachers' digital literacy capabilities by developing apps that can be used for recorder duet in elementary schools using App Inventor. As a procedure for developing an app, not only the process of uploading recorder scores and sound sources to the app, but also the design and coding process of the app development tool "App Inventor" was provided in detail.

The app developed through this study can be used as a tool for digital literacy competency development, inner hearing, and self-directed instrumental music learning for students. Going beyond using already released off-the-shelf apps, it is a very meaningful task in a digital education environment to enable necessary materials to be driven in the app through a simple block coding process even if the teacher is not a computer expert.

The positive aspects of the developed app are as follows. First, sample performance was provided so that students could play the pitch properly while maintaining the steady beat. Second, students can practice listening to the counter part, so they can effectively do the ensemble. Third, the teacher's acoustic piano accompaniment enables an aesthetic music experience in sound and musical expression. On the other hand, through the evaluation of this app, it was proposed to provide repetitive practice for long songs and to vary the tempo.

In the study the contents and functions of the app were evaluated by 4 pre-service elementary teachers, but suggestion was made that a study to further supplement the function and contents of the app through evaluation of teachers and students after actual use in elementary school. It is also expected that apps for ensemble training with other instruments other than the recorder will continue to be developed.

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